Logistics Management Institute

How CALS Can Improve the DoD Weapon System Acquisition Process

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LMI

Executive Summary

HOW CALS CAN IMPROVE THE DoD WEAPON SYSTEM ACQUISITION PROCESS

In 1988, the Deputy Secretary of Defense directed the Military Departments and the Defense Logistics Agency to employ Computer-aided Acquisition and Logistics Support (CALS) technology for all new weapon systems and, where feasible, for weapon systems currently under development. Since then, a number of successful CALS technologies have been incorporated into various weapon systems. To guide DoD-wide CALS implementation, the Deputy Secretary of Defense needs to know where the highest potential payoffs are for CALS investments and what changes in business practices are needed to realize those payoffs.

We applied conservative projections of CALS benefits developed from industry and DoD CALS prototype experience to workloads and elapsed times recorded for 128 DoD weapon system acquisition programs.* We found that on a typical weapon system acquisition program, using CALS can save more than 1,000 workweeks (19 workyears) of DoD effort and 1,250 weeks of time.** Savings were estimated for DoD engineering, test and evaluation, and manufacturing processes in the demonstration/validation and the engineering and manufacturing development phases. The processes in those two phases represent the most labor-intensive and longest duration activities for DoD in the acquisition process. Additional savings in other processes and other phases are likely.

After reviewing the weapon system acquisition data base for the 128 weapon system programs and considering potential CALS solutions to known acquisition problems, we recommend that the Deputy Secretary of Defense implement nine specific CALS applications in four acquisition processes: concurrent engineering

* These programs are from a weapon system acquisition data base derived from one developed for the Defense Science Board.

** This figure represents the cumulative number of calendar weeks eliminated from individual acquisition activities. Acquisition schedules would be shortened by fewer than 1,250 weeks since many acquisition activities are concurrently executed.

support, engineering change proposal processing, technical data packages, and provisioning. Exemplary applications include the use of CALS to establish a concurrent program management capability for DoD that mirrors industry's concurrent engineering approach and to accelerate the engineering change proposal process.

A conservative estimate of savings for these nine applications in the four acquisition processes is $165 million a year. If the recommended applications are implemented, the new electronic document review and approval process and other CALS capabilities would also provide savings in other processes that we did not capture in this study. The recommended applications will be cost-effective even when telecommunication and implementation costs for modifying and integrating existing information systems and converting legacy (i.e., pre-CALS) data are taken into account.

Before implementing our recommendations, DoD must modernize its infrastructure (hardware, software, and telecommunications capacity) to support digital processing of data from the contractor to the program manager to the supporting activities and back to industry. Joint CALS, the Joint Engineering Data Management and Information Control System, and Contractor Integrated Technical Information Service are major parts of this infrastructure modernization. The CALS applications also require changes in business processes before most savings can be achieved. Some examples of those changes in business processes include the active participation of production and logistics experts much earlier in the weapon system acquisition cycle (i.e., throughout design), a shift in decision-making patterns from periodic to nearly continuous review and approval, and a new ability for item managers to stop spare parts procurements more quickly when design changes make them inappropriate. Such changes must have the support of functional managers and many must be reflected in revisions to functional standards.

While current CALS data exchange standards in draft form are adequate to support the recommended CALS applications, they need to be refined and approved to encourage more active support from program managers and contractors for CALS requirements in acquisition contracts. Implementation guides similar to those prepared for electronic data interchange are needed to give specific guidance to both DoD and contractors on CALS data exchange for particular transactions or processes.

The new DoD acquisition strategy (i.e., developing the required new technology but delaying production until the system is needed) will require CALS capabilities to access technical data from the development effort quickly (perhaps by a contractor other than the developer), do any necessary redesign, and put the weapon system into production. Even if fewer systems go into production and operation (where many of the CALS benefits are realized), CALS can be applied to modifications to extend the life of existing systems and it will offer many of the same benefits it offers to new systems.

The use of CALS is a cost-effective way to improve acquisition and logistics processes throughout the weapon system life cycle. The technology to implement it is available and the need to streamline business functions is urgent. No more prototyping is needed to support CALS digital data exchange; DoD needs the initial infrastructure investment and functional management support. With the infrastructure in place, program managers can effectively acquire CALS-compliant digital data and DoD functional managers can receive, store, and effectively use the data throughout DoD.

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CHAPTER 1

INTRODUCTION

In 1988, the Deputy Secretary of Defense directed the Military Departments and Defense Logistics Agency (DLA) to employ Computer-aided Acquisition and Logistics Support (CALS) technology for all new weapon systems and, where feasible, for weapon systems currently under development. Since then, a number of successful CALS technologies have been incorporated into various weapon systems. CALS will shift weapon system development from its present paper-intensive environment to a highly automated, integrated one. This report defines areas in which CALS technologies can change acquisition business practices for all weapon systems on a DoD-wide basis. Through CALS, DoD can reduce costs and time to production as well as improve quality. This report describes implementation steps and schedules and any necessary changes in policies, procedures, or standards for selected, high-payoff business practice changes.

BACKGROUND

Computer-aided Acquisition and Logistics Support

Computer-aided Acquisition and Logistics Support technology offers a method to improve the digital exchange of data between weapon system contractors and DoD. CALS is expected to reduce development time and life-cycle cost for weapon system acquisition. Initial attention focused on developing CALS digital data exchange standards. Emphasis is now shifting to data base integration and product data standards. Definitions of CALS vary from restrictive ones that equate it merely to data exchanges between the Government and a contractor to more-expansive ones that consider practically any automation effort to be CALS.

For this study, we define CALS as the digital exchange of data (whether that exchange is between DoD and contractors or between DoD activities). We further extend the definition to include those software applications that accept digital contract data deliverables for processing. We limit our consideration of CALS applications and savings to those that DoD Components (the Military Services and the DLA) can achieve directly. In other words, CALS applications that fall in the contractor's domain and whose savings accrue to DoD indirectly through lower contract costs are not considered in this study.

While we focus primarily on existing CALS technology for data interchange, we also consider potential data base integration where near-term alternatives are feasible. An example of a near-term alternative would be the use of magnetic media to transmit data rather than electronic transmission over telecommunications networks.

Recent DoD Weapon System Acquisition Results

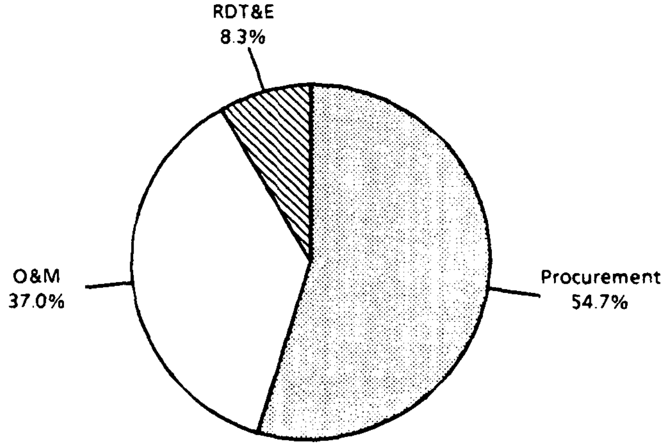
Weapon system acquisition costs and development times have been increasing. If the CALS program is to accomplish its goals of improving weapon system acquisition, its applications must reduce costs and shorten development schedules. In the following subsections, we illustrate current trends in weapon system acquisition costs and schedules and the key elements of those costs and schedules.

Costs

Any effort to reduce the costs of weapon systems must address procurement and supply costs. Figure 1-1 presents the distribution of research, development, test and evaluation (RDT&E) procurement, and operations and maintenance (O&M) costs for 40 major weapon system programs. That distribution demonstrates the significance of weapon system procurement and support costs. Figure 1-2 shows the cost distribution for selected weapon system categories. Although RDT&E represents a much larger share of platform electronics systems than of other systems, in every case procurement and support costs represent by far the majority of weapon system costs.

Schedules

Based upon the recent experience of 128 weapon system programs, the current acquisition timeline is approximately 16 years from mission analysis to initial operating capability (IOC). As shown in Figure 1-3, full-scale development (FSD) [now called engineering and manufacturing development (EMD)], is the longest and most labor-intensive phase in the acquisition cycle. The demonstration/validation (dem/val) and EMD phases of acquisition have experienced a 60 percent increase in duration since the 1950s (see Figure 1-4).



Note: Data from December 1991 Selected Acquisition Reports (SAR); O&M includes military construction (MILCON); RDT&E = research, development, test and evaluation.

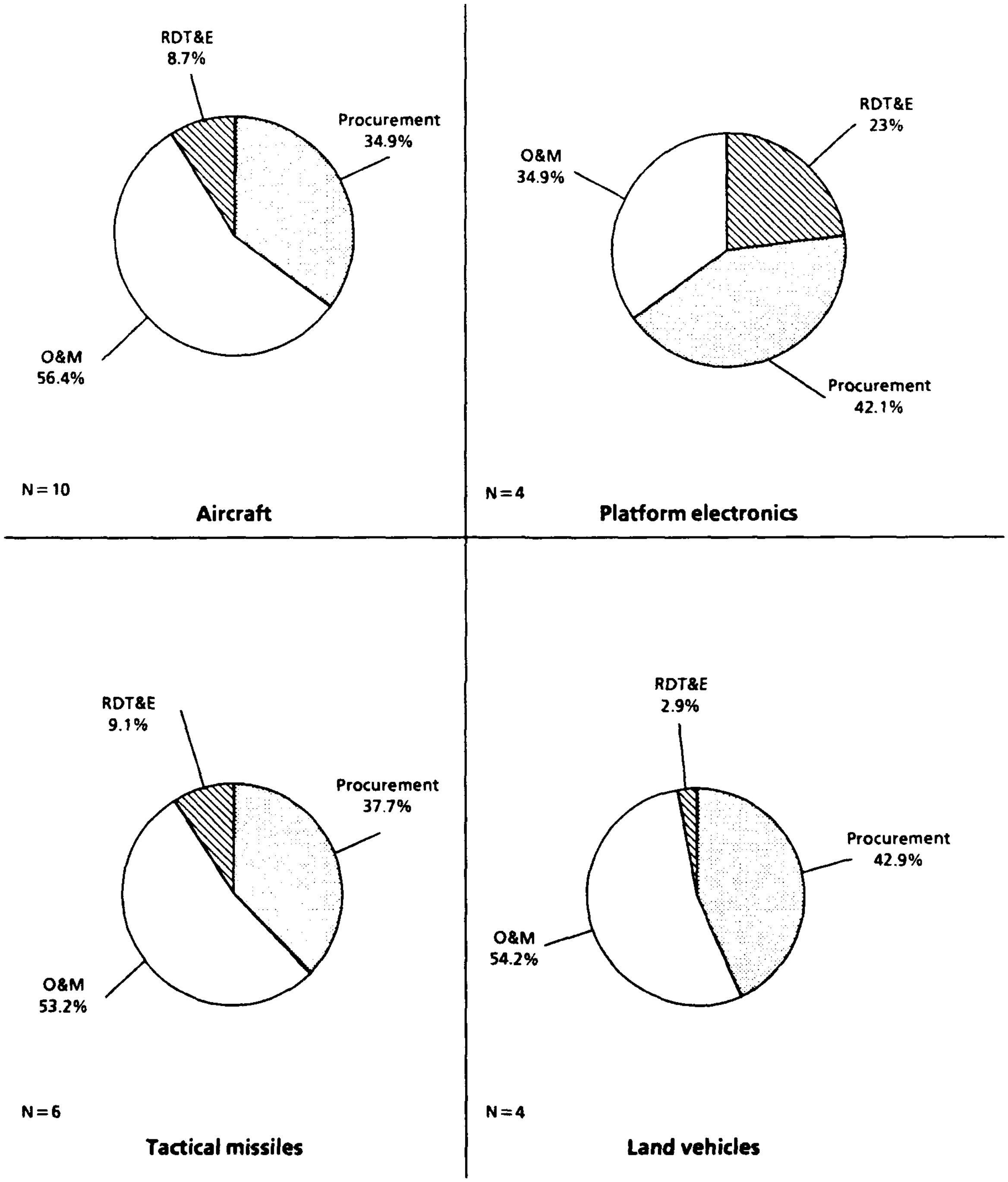
FIG. 1-1. WEAPON SYSTEM COST DISTRIBUTION

Even though the demise of the Soviet bloc has reduced the apparent "threat" to national security, policymakers should remain concerned about how long it takes to develop and field a weapon system for several reasons. First, reduced development time means lower cost and lower program risk. Second, a rapid development cycle would allow the United States to maintain a technological edge against any potential adversary. Third, rapid fielding, improved production surge, and a more rapid force reconstitution provide an effective U.S. response to a major threat and are critical aspects of a credible deterrent.

SUMMARY OF FINDINGS

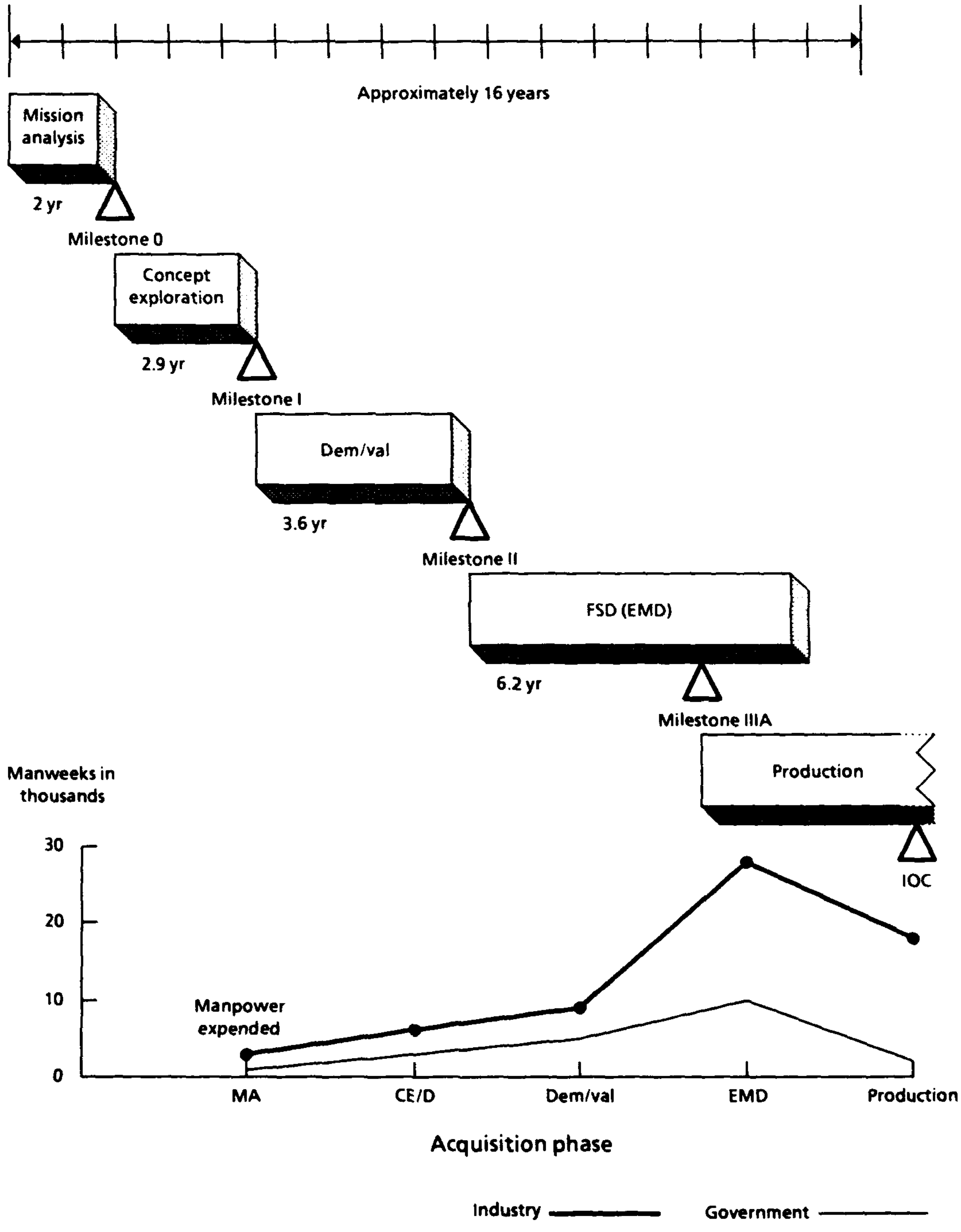
Calculations from the Acquisition Data Base

We reviewed 128 acquisition programs in a previously developed data base and found that engineering, test and evaluation, and manufacturing processes in the dem/val and EMD phases require the most time and the most labor in the weapon system acquisition cycle. A conservative approximation of the savings that can be realized for a typical acquisition program by implementing CALS within those phases is 1,010 workweeks (19.4 workyears) and 1,252 calendar weeks. The calendar week savings represent the cumulative calendar weeks saved by individual



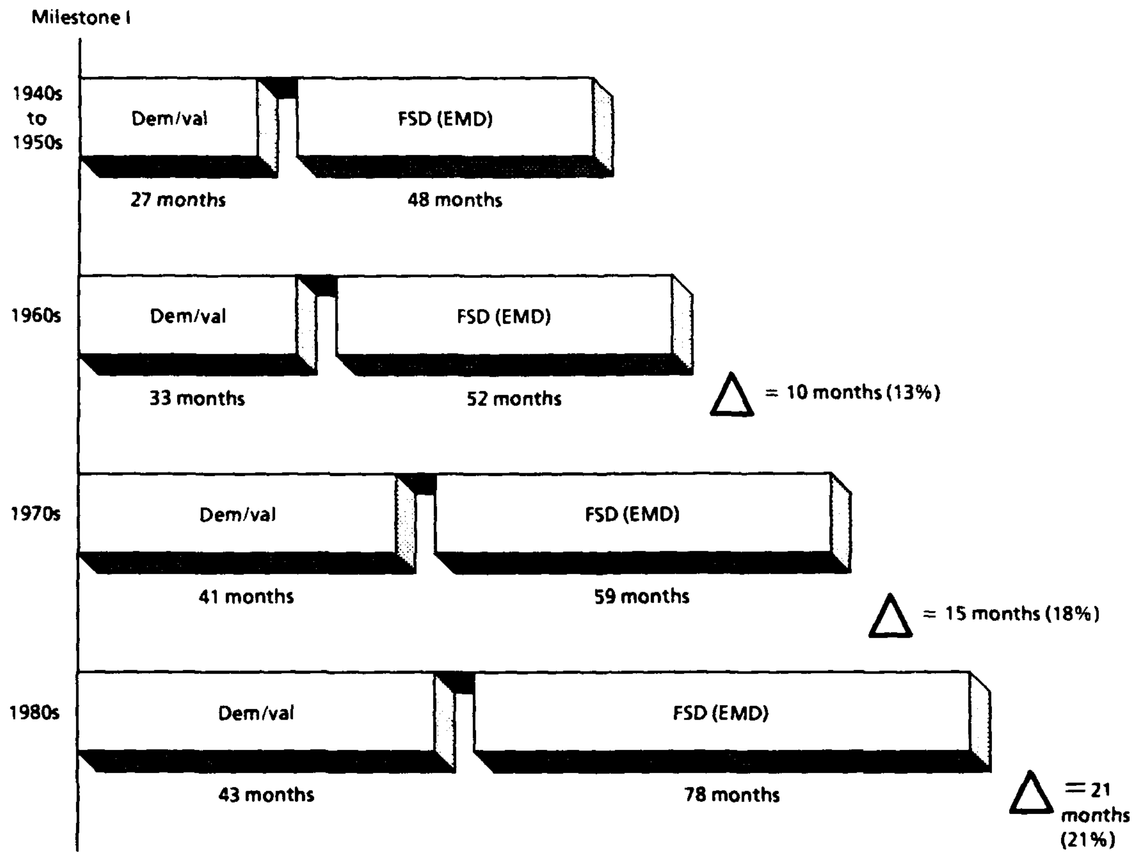
Note: Data from December 1991 SAR; O&M includes MILCON.

FIG. 1-2. COST DISTRIBUTION FOR SELECTED WEAPON SYSTEM CATEGORIES



Source: Defense Science Board Acquisition Streamlining Task Force.
Note: MA = mission and threat analysis; CE/D = concept exploration and definition.

FIG. 1-3. ACQUISITION PROCESS TIMELINE (ALL SERVICES)



Source: Defense Science Board Acquisition Streamlining Task Force.

FIG. 1-4. LENGTHENING DEVELOPMENT (ALL SERVICES)

acquisition activities. Since many activities are concurrent, overall program schedule reductions would be fewer than 1,252 weeks.

High Payoffs

The implementation of CALS affects all phases of the weapon system life cycle, and our specific "high-payoff" applications are based on how selected changes to business processes would affect not only the dem/val and EMD phases but also all other phases of the weapon system life cycle. The highest payoff areas are concurrent engineering (CE) support, engineering change proposal (ECP) support, technical data packages (TDPs), and provisioning.

Concurrent Engineering

To provide CE support, DoD establishes a multi-disciplinary team that mirrors the contractor CE team and works with it. CALS technology would give the DoD CE team access to data and enable it to coordinate reviews and decisions electronically. CALS would also improve parts selection by providing contractors with better access to the DoD supply system and streamlining the decision process in selecting parts. A conservative DoD-wide savings estimate for these applications is $28 million per year, with the largest amount coming from a change in business practices. With CALS, fewer new parts would be procured and fewer new sources of supply would need to be qualified ($24 million DoD-wide savings per year).

Engineering Change Proposals

Contractors prepare ECPs to describe changes they recommend to Government-approved weapon system design baselines. The Government reviews the technical and financial aspects of each ECP before approving or rejecting it.

The Department of Defense processes approximately 100,000 ECPs each year. Any delay in approving them delays their incorporation on the production line; increases retrofitting costs; and increases obsolete technical documentation, training, and spare parts. Using CALS to submit, process, and track ECPs as well as to expand and integrate existing digital ECP processing capabilities will save approximately $126 million per year DoD-wide (including $10 million from reduced retrofitting). Although CE should reduce the total number of ECPs significantly in the future, timely review and approval of the lower volume of ECPs is expected to remain cost-beneficial.

Technical Data Packages

Technical data packages consist of the engineering drawings, parts lists, and other engineering data required to manufacture, modify, operate, and maintain weapon systems. Today, most TDPs are delivered to the Government on aperture cards, and for a major weapon system, the TDP can consist of many thousands of aperture cards. TDPs are difficult to review and bulky and expensive to store, and their distribution to activities that need them is often slow. The Joint Engineering Data Management and Information Control System (JEDMICS) will provide the infrastructure to store and access digital TDPs. In the technical data policy area, however, digital TDP delivery is optional and TDP distribution patterns remain unchanged. We recommend that they be submitted in digital form and that automation of TDP reviews be increased and that initial distribution of TDPs and updates be broadened to include all activities supporting the weapon system; we also recommend that DoD ultimately establish a consolidated data repository system. Savings would accrue from earlier organic supply support for weapon systems, increased competition in procuring spares, less duplication in legacy data conversion, and reduced repository processing of TDPs. We estimate savings through data indexing workload reductions alone at $4 million per year.

Provisioning

Provisioning is the process through which we identify weapon system repair parts that should be stocked to support weapon system maintenance. As a weapon system's design changes, however, provisioning decisions must be adjusted when parts are added and deleted from the weapon system configuration. Other changes (e.g., those in maintenance procedures) also affect the replacement rate of parts and, therefore, the quantities that should be provisioned. Delays in notifying supply support organizations of these changes result in wasted effort and the procurement of parts that will never be used. Also, speeding the supply support process permits organic support for weapon systems, reducing DoD reliance on expensive contractor interim support and increasing weapon system supportability in combat environments. Recommendations are to implement DLA's Data Review, Analysis, and Monitoring Aid (DRAMA) or its functional equivalent and expand it to conduct on-line provisioning conferences and to require contractors to submit the digital supplementary provisioning technical documentation (SPTD) used to describe parts and assign National Stock Numbers (NSNs). DoD-wide savings arising from not procuring inapplicable/excess inventory are estimated at $7 million per year. Digital SPTD submission will reduce the time required to achieve organic supply support by weeks for each weapon system.

Investments

The CALS initiative embraces the generation, access, management, and interchange of digitized data. In order for DoD and industry to realize the full benefits of these operations, enabling technology must be in place. Implementing these CALS technologies and achieving the savings discussed above will require some investments. Those investments are primarily for modification and integration of existing systems, conversion of legacy data to CALS-compliant formats, and telecommunications charges for supporting the electronic transfer of data. Most of those costs are captured in other initiatives [e.g., Joint CALS (JCALS), JEDMICS, Contractor Integrated Technical Information Service (CITIS), and corporate information management (CIM) projects].

Prerequisites

The primary prerequisite to our recommended CALS applications is a modernized DoD infrastructure of hardware, software, and telecommunications systems that will support the digital processing of data from the contractor to the program manager to the supporting activities and back again to industry. This modernization is continuing and much of it occurs in support of information systems modernization and normal replacement. DoD must have a good portion of this modern infrastructure in place if it is to realize the expected benefits from CALS applications; whenever digital data must be reduced to paper or microform for continued processing or re-entered into another system, much of the anticipated value from the CALS application is lost.

Change in Business Practices

Most of the savings identified (whether in time or dollars) are dependent on process change and process change often requires that functional directives and standards be revised and personnel undergo a cultural change. CALS is the tool or catalyst that makes such process change possible. Individual functional managers, rather than CALS managers, need to understand and initiate the process changes needed to successfully implement the CALS applications. In Chapter 4, we identify specific directives and standards and their functional proponents for the recommended applications.

Another policy issue related to CALS implementation is the need for DoD to accept slightly increased costs and schedules in the earlier acquisition phases to gain significant overall life-cycle savings. DoD and industry must also coordinate the timing of the requirement for CALS data delivery with DoD's ability to process CALS data.

Today's CALS data exchange standards do not need any significant changes to implement our recommended CALS applications, but they do need to be refined and approved. DoD versions of industry and international text and graphics standards need to be kept compatible with the controlling standards, and that requires specific review and update responsibilities to be assigned within DoD. In addition to the standards, implementation guides are needed to provide guidance to both DoD and contractors on CALS data exchange for particular transactions or processes.

Finally, the value of CALS is enhanced even more when looked at from the perspective of the "new" DoD acquisition strategy of developing new technology but delaying its production until needed. Since many of the benefits from CALS accrue later in the life cycle, a legitimate question can be raised as to whether CALS would be cost-effective under the new strategy. Even if fewer weapon systems enter production, many existing weapon systems will undergo Service Life Extension Programs (SLEPs) or other modification programs to extend their life spans. Those extra modification programs will follow the full acquisition and operational cycle; CALS will be as relevant for those programs as it is for new weapon system programs. Even the programs that are put "on the shelf" will need to be "dusted off" (perhaps by contractors other than the ones who developed the system) and will need, more than ever, to be easily producible and affordable to operate. CALS is the best way to make design data available immediately to support redesign and rapid production of the activated systems.

CHAPTER 2

ANALYTIC APPROACH

This chapter describes our analysis of the weapon system acquisition data base and our identification of the CALS applications.

ANALYSIS OF THE WEAPON SYSTEM ACQUISITION DATA BASE

The data base consists of information from 128 weapon system acquisition programs. Each program provides information on each of 840 acquisition activities it had performed in its current or most recent past acquisition phase. Information collected for each activity included work effort expended, the beginning and ending dates, the inputs required to perform the activities and the outputs from the activity, and the policy document(s) that authorized or required the activity.

We searched the data base to discover responses that varied from other responses for similar programs by a significant amount (outliers). We then analyzed the outliers to determine whether any aspect about the program could explain the variation and whether the variation was significant enough to affect calculated means for the data in question. In every case except one we found that the outliers do not have a significant effect on the means calculations.

The next step was to identify any statistically significant differences among the Services or the types of weapon systems that might suggest the need for different approaches to CALS implementation.

We assessed schedule activities and cycle times on the basis of an existing network process model of the weapon system acquisition process. That model is supported by the acquisition data base. Using the model and the data base, we identified labor-intensive, long-duration, and critical-path activities. The results of these analyses were used to identify acquisition phases and processes with the greatest potential for high-payoff CALS opportunities. After identifying these high-potential acquisition phases and processes, we identified activities in the model that were associated with each process and identified those activities that could benefit from CALS application (see Appendix A).

To calculate potential CALS savings for each of the activities that had high CALS potential, we collected historical savings data from several sources and structured them into the following six categories in terms of percentage reductions in applied or elapsed time (see Appendix B):

- Category I: Automated review and approval process
- Category II: Electronic access to contract data requirements list (CDRL) data
- Category III: Access to contractor analysis tools
- Category IV: Electronic data interchange (EDI)
- Category V: Digital data delivery
- Category VI: Concurrent engineering.

We analyzed each activity with high potential for CALS payoffs for potential savings in each of the six categories. For those categories where savings were likely, we calculated savings by applying the lowest savings estimate for that category against the activity's mean applied and/or elapsed time. Calculated savings for all activities were added to estimate the cumulative savings in work effort and calendar weeks for a typical weapon system acquisition (see Appendix C).

We captured both workload and calendar week savings for Government activities, but only calendar week savings for contractor activities. Workload savings for contractor activities exist and will accrue to the Government indirectly through reduced contract costs, but contractor workloads were not adequately documented in the data base to support savings estimates.

DEVELOPMENT OF CALS APPLICATION RECOMMENDATIONS

We identified high-payoff CALS applications in the acquisition process that could be directly implemented by DoD (rather than by a contractor through an acquisition contract). For our purposes, we define the acquisition process as beginning at program start and ending at IOC. We consider savings that accrued anywhere in the life cycle, including the post-IOC operations and support phase.

We began our analysis with a review of the weapon system data base and then broadened it to consider other known acquisition problems and cost drivers not considered by the data base. We then narrowed our consideration to focus detailed analysis on those CALS applications with the highest potential returns. In the following subsections, we describe our analytical process in more detail.

Analysis of the Data Base

The data base as maintained by The Analytic Sciences Corporation (TASC) offered the best available empirical information on weapon system acquisition activities. We started our analysis of CALS applications by taking advantage of its readily available information. We expected to use the data base process model as the current or baseline model of the acquisition process, and from it, develop a future model (one in which CALS is used). We could then measure the differences in applied and elapsed times between the two models to estimate the time and workload savings attributable to CALS implementation.

The data base provided information on the total workweeks of effort and the total calendar weeks of time required for each activity, and it identified the directive authority under which program offices conducted each activity. While that information was valuable, the acquisition process model based on it was not sufficiently detailed for our analysis. At the high level represented in the model, nearly all activities described would need to be performed regardless of streamlining. The model did not have enough detail to specify process changes (elimination of steps or reduction of effort) without being further developed to a level of detail two or three stages lower. For example, the model describes the process "Conduct Provisioning Conference." That function is needed, but its description in the TASC model does not aid in identifying the underlying activities, and it is in those underlying activities that CALS could be applied to improve the process and provide benefits.

Furthermore, since the data base primarily captures workload and schedule information, analyzing it would tend to identify applications that would produce labor or schedule savings. Since other potential benefits could accrue from applying CALS (e.g., reductions in inapplicable inventory), if we restricted our analysis to the TASC model, we would not have been able to identify or measure the widest possible range of potential CALS benefits.

Ultimately, we chose to identify the 25 activities in the data base that had the highest applied times under the assumption that any improvement in those activities would result in significant labor savings (see Appendix D). Review of those top 25 activities indicated that they were grouped primarily in the test and evaluation and the engineering and configuration management functions. This information became one consideration in our analysis of potential high-payoff areas.

Broadening the Scope of Analysis

One of our tasks was to identify practical CALS applications that would readily benefit program managers. On that basis, we reviewed the literature for known acquisition problems. An outline of acquisition problems is at Appendix E.

We also considered other potential benefits that could be gained from improved acquisition processes, such as reduced procurement of inapplicable/excessive inventory, reduced time to achieve organic supply support, reduced operating and support costs, and improved supportability/availability of the weapon system.

Narrowing the Scope of Analysis

We analyzed each problem or potential benefit identified to see whether CALS could contribute to its solution. Many acquisition problems are rooted in funding fluctuations, requirements changes, procurement policies that force inefficiencies, and other causes for which CALS cannot offer a direct solution. In other cases, CALS could offer a solution but not the best solution. For example, if better management practices alone could solve a problem, we did not apply a CALS solution as a substitute.

We also considered whether DoD played a key role in each particular CALS solution. If the primary implementation responsibility for a CALS solution was with industry, we dropped it from further consideration. Finally, we examined whether current CALS technology could support near-term implementation. If not, we dropped the solution from consideration.

At this point, we had identified particular acquisition functional areas that were related to high labor costs, known acquisition problems, and other non-labor-saving benefits that were also amenable to improvement through near-term DoD CALS applications (see Appendix F). We then rated and ranked these processes in terms of the value of their potential benefits (see Appendix G). Highest value was placed on those benefits with the largest effect over the life cycle. Next highest value was placed on those benefits offering a high degree of collateral benefit (i.e., where implementing the CALS application for the target process would provide a capability for improving several other processes as well). Finally, the lowest value was placed against benefits that accrued only within the particular process (e.g., marginal labor savings in the process itself, with no direct downstream benefit from reduced schedule or cost).

Documenting CALS Applications

In documenting proposed CALS applications, we sought to provide specific information that would aid implementation efforts. We provide as much information as possible for each proposed CALS application in Chapter 4. The information is presented in sections described as follows.

Prerequisites

In many cases, CALS applications are dependent on the presence of particular infrastructural, policy, or interface environments before they can be effective. This section addresses those prerequisites to implementation and helps to calculate when the particular application can be effectively implemented DoD-wide.

Schedule Impacts

This section addresses the schedule improvements expected from implementing the proposed CALS application. Where the improvements are quantified, the estimate is usually derived from other studies that have identified elapsed time savings from similar technology applications.

Savings Impacts

Savings in all areas except the schedule are described in this section. Tangible savings are quantified wherever sufficient data could be gathered. Quantified savings are on the conservative side since they do not consider the potential collateral benefits that may accrue from using the application to improve processes other than the one targeted in the recommendation. Although we limited our analysis to Government savings, contractor savings will also eventually be savings to the Government. We made no attempt to determine what portion of estimated savings would be additional to those already anticipated by Defense Management Review (DMR) reductions.

Investment Requirements

This section attempts to capture the cost of implementing the proposed CALS application. Tangible costs were not quantified unless realistic cost figures could be obtained.

Policy/Regulatory Implications

In most cases, CALS is simply a tool for use by the functional manager of a process to improve that process. This section identifies the policy changes to functional directives and standards that would be required to implement the process improvements made possible by the proposed CALS application.

Proposed Implementation Plan

We prepared a Gantt chart for each proposed CALS application displaying the prerequisites and the particular tasks required to implement the application DoD-wide. Action offices and expected task durations were also included. These implementation plans are initial estimates only and require thorough coordination with all action offices prior to approval and execution.

CHAPTER 3

FINDINGS AND CONCLUSIONS

This chapter presents the findings and conclusions from our study of potential CALS impacts on the weapon system acquisition process. They are separated into those that relate to the existing acquisition process and those that result from the development of specific CALS application recommendations.

THE WEAPON SYSTEM ACQUISITION PROCESS

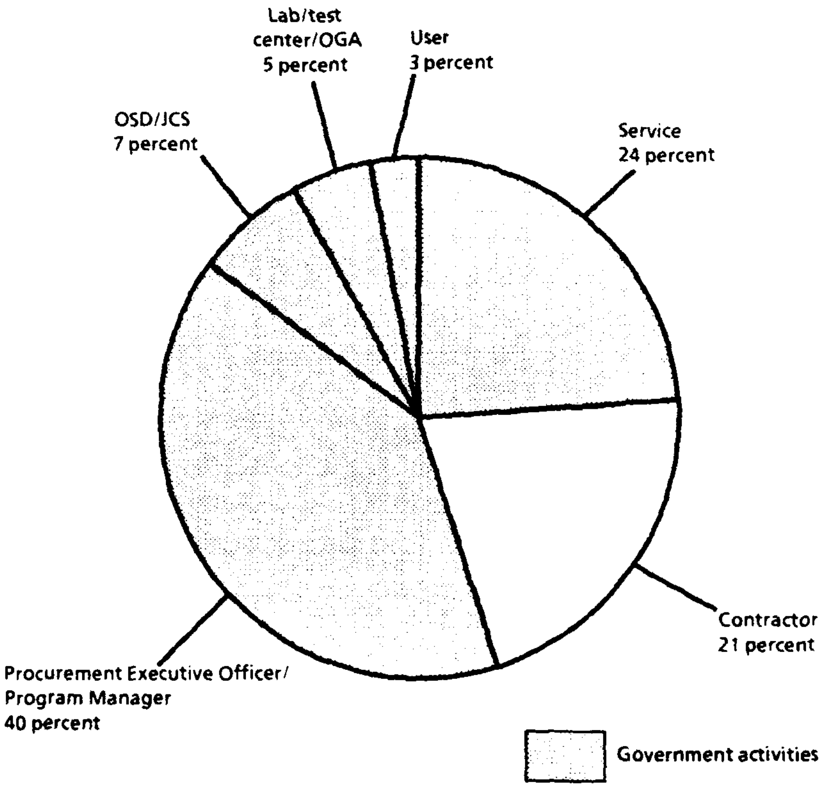
The findings and conclusions presented in this section are based on statistical analysis of the network process model of the weapon system acquisition process and its underlying data base of 128 weapon system programs.

Acquisition Cycle Time

Our goal in reviewing the acquisition process and analyzing potential CALS applications was to reduce acquisition costs and schedules. We assumed that by reducing the workload (i.e., the applied time) needed to perform acquisition activities, we also reduced the acquisition cost. We also assumed that by reducing the duration (i.e., the elapsed time) of acquisition activities, particularly of those activities on the critical path, we would reduce acquisition schedules. Therefore, we began our analysis by identifying those activities that were on the critical path, reflected a high mean applied time, or a high mean elapsed time.

Critical Path Activities

As shown in Figure 3-1, nearly 80 percent of the activities on the acquisition model's generic critical path for all acquisition phases are Government activities. Nearly 90 percent of the functions represented in critical path activities could benefit from CALS applications (see Figure 3-2). These findings suggest that DoD can play a key role in reducing acquisition schedules through use of CALS.



Note: JCS = Joint Chiefs of Staff; OGA = Other Government activity.

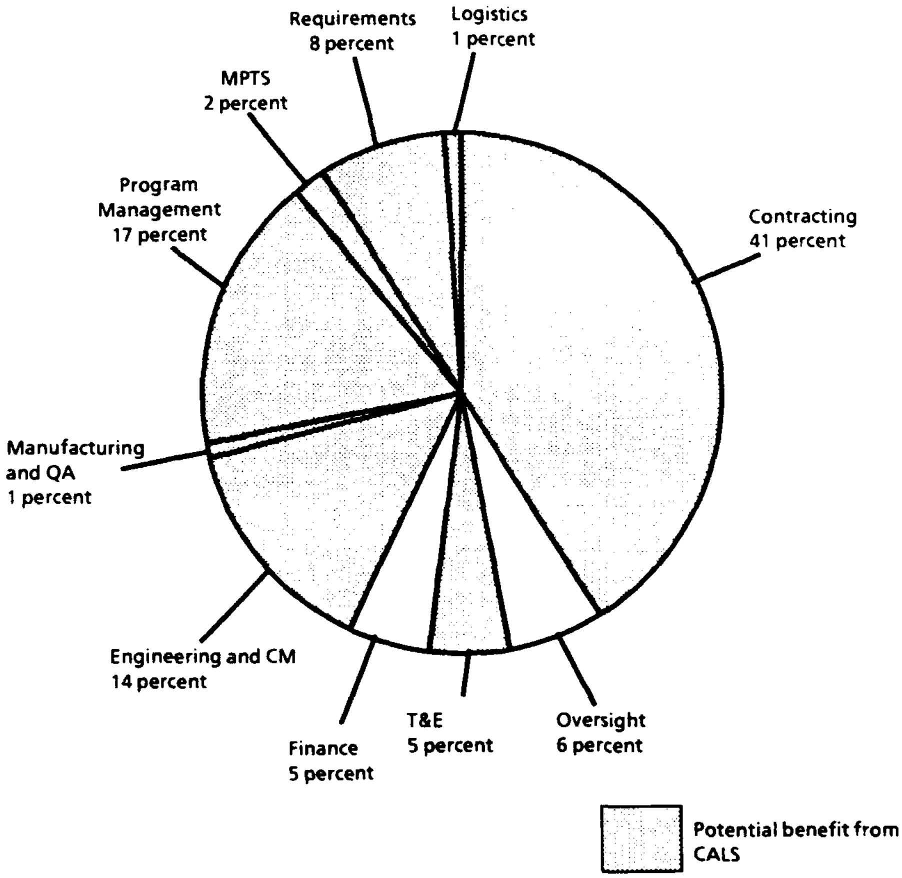
FIG. 3-1. CRITICAL PATH ACTIVITIES (PERFORMER DISTRIBUTION)

Long-Duration Activities

When acquisition activities were ranked by duration (i.e., mean elapsed time to complete the action), most of the upper 10 percent of activities were in the dem/val and EMD acquisition phases (see Figure 3-3) and most of those activities entail engineering and configuration management (CM), program management, and test and evaluation (T&E) functions (see Figure 3-4). This suggests that CALS implementation should be directed to these phases and functions in order to reduce acquisition schedules.

Labor-Intensive Activities

Similarly, we ranked all acquisition activities by mean applied time. Again, the majority of the 10 percent of activities with the highest mean applied times were in the dem/val and EMD phases (see Figure 3-5). The majority of the 10 percent



Note: QA = quality assurance; MPTS = manpower, personnel, training, and safety.

FIG. 3-2. CRITICAL PATH ACTIVITIES (FUNCTION DISTRIBUTION)

highest applied time activities are in the T&E, engineering and CM, and logistics functions (see Figure 3-6). This suggests that CALS implementation should be directed to these phases and functions in order to reduce acquisition personnel costs.

Acquisition Functions with High Potential CALS Payoffs

The T&E and the engineering and CM functions in the dem/val and EMD acquisition phases have the most impact on weapon system acquisition costs and schedules and should be the primary targets for CALS applications. We also considered the impact manufacturing has on schedules since it is a major function under contractor control that can benefit from CALS application.

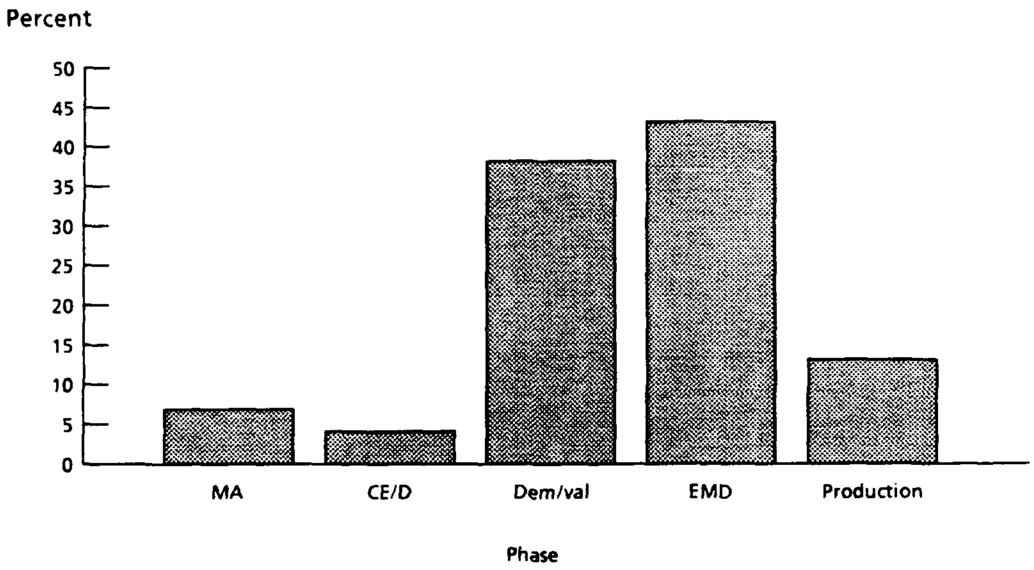


FIG. 3-3. ACQUISITION PHASE DISTRIBUTION OF UPPER 10 PERCENT OF ACTIVITIES BY DURATION

Appendix A identifies the acquisition activities associated with each of these three functions for both dem/val and EMD phases. The activities are presented as a logical flow of predecessors and successors on the basis of activity descriptions and input/output products. Each activity was further reviewed to determine whether it would benefit if CALS were applied to it. Those activities that could benefit from a "near-term" CALS application are shaded in the charts in Appendix A. We made no attempt to re-engineer the process flow by combining or eliminating activities. Thus, the shaded boxes represent a conservative estimate of potential CALS impacts.

Potential CALS Savings

We searched the open literature for historical savings data for previous CALS implementations and identified savings estimates in the following six categories (see Appendix F):

- Category I: Automated review and approval process
- Category II: Electronic access to CDRL data
- Category III: Access to contractor analysis tools

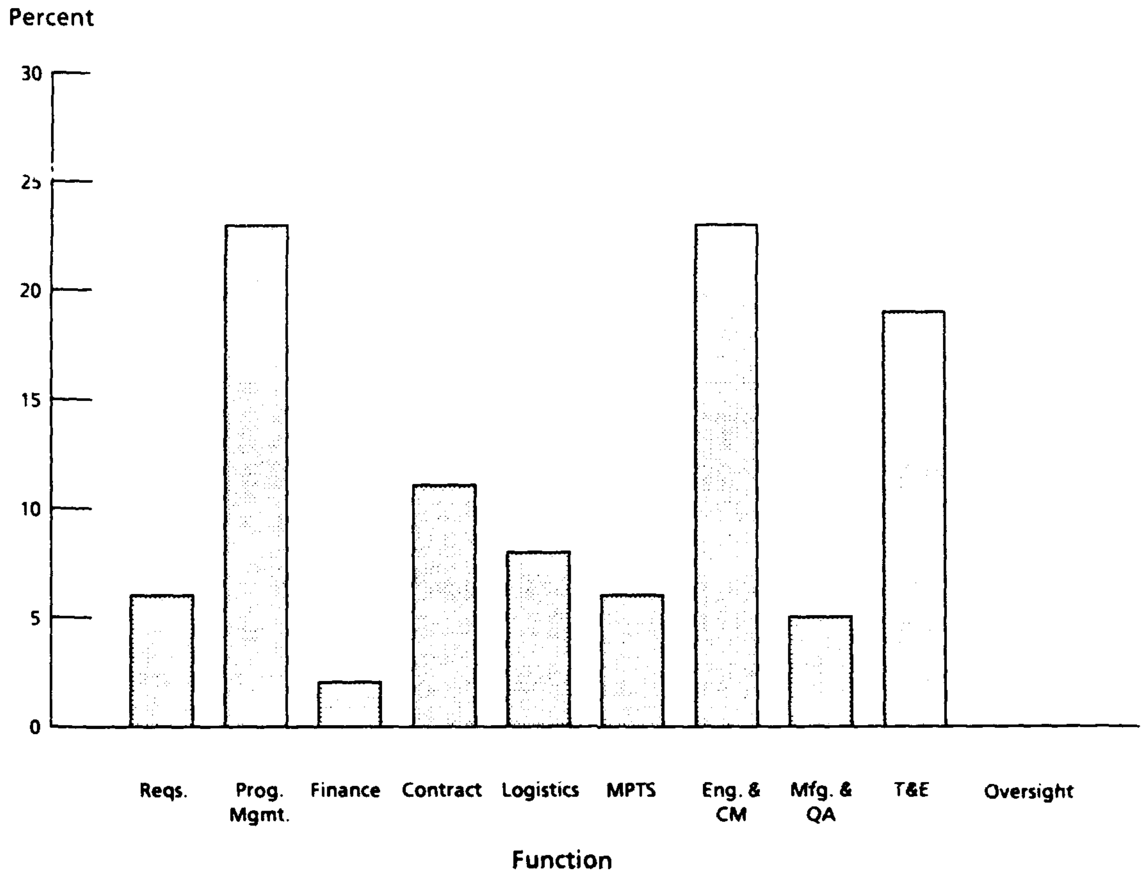


FIG. 3-4. DISTRIBUTION OF 10 PERCENT OF ACTIVITIES TAKING THE MOST TIME BY FUNCTION

- Category IV: EDI
- Category V: Digital data delivery
- Category VI: Concurrent engineering.

Those six categories represent six CALS "capabilities." Each activity in the three targeted functions (engineering and CM, T&E, and manufacturing and QA) that could most benefit from CALS (i.e., the shaded boxes in the charts in Appendix A) were analyzed to determine the beneficial effects of applying those six CALS capabilities. If we found that an activity could benefit from a particular CALS capability, we reduced its mean applied and/or elapsed time by the most conservative savings estimate for that capability. Where an activity would benefit from more than one CALS capability, we limited savings estimates to some combination of the

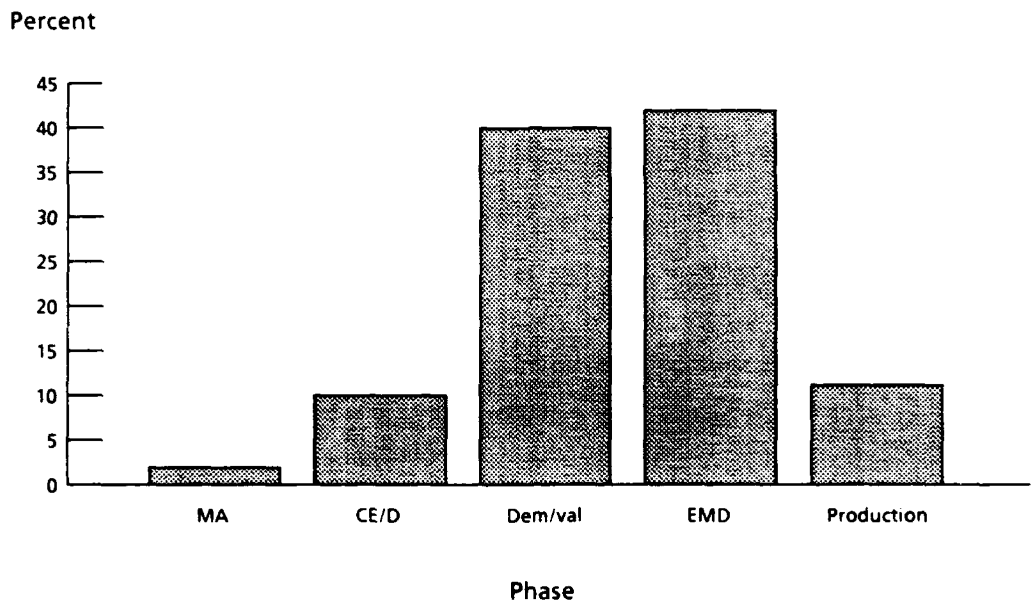


FIG. 3-5. ACQUISITION PHASE DISTRIBUTION OF THE UPPER 10 PERCENT OF ACTIVITIES BY GOVERNMENT MANPOWER EXPENDITURE

savings estimates for the individual categories. Total estimated savings were accumulated by function by acquisition phase. Appendix C presents the calculations of the potential CALS savings.

In aggregate, by implementing CALS, DoD can expect to directly save at least 1,010 workweeks (19.4 workyears) for a typical weapon system program. At least 1,252 calendar weeks could also be saved from individual activities (including contractor activities) although the overall program schedule will be reduced by less calendar time since many of the activities are performed concurrently.

Regulatory Considerations

The CALS capabilities alone cannot change or streamline the acquisition process. As an integral aspect of the study, we identified governing regulations, responsible DoD offices, and the potential changes to the regulations to enhance

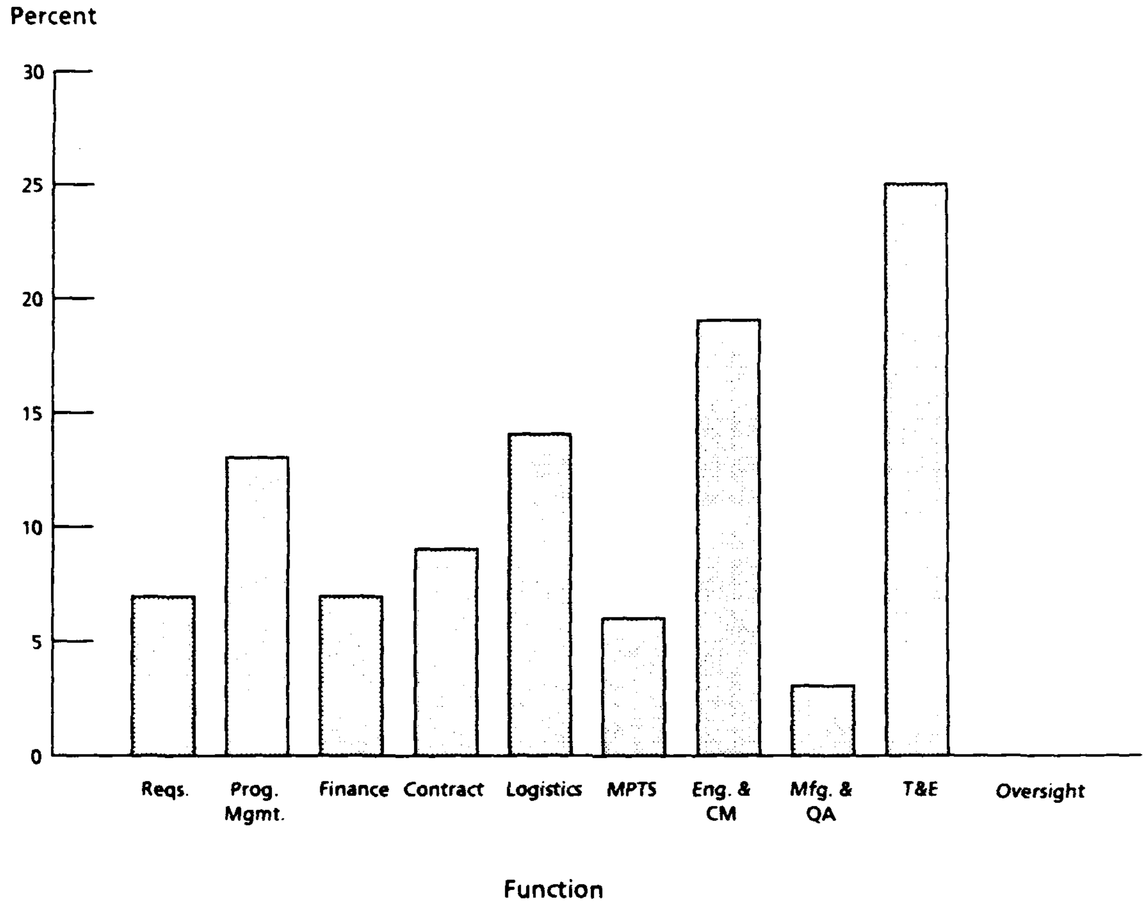


FIG. 3-6. DISTRIBUTION OF THE 10 PERCENT OF ACTIVITIES TAKING THE MOST GOVERNMENT MANPOWER BY FUNCTION

process streamlining and CALS applications. We found the following military standards, directives, and specifications require revision:

- Military Standard (MIL-STD)-499B (Draft), *Engineering Management*
- DoD Standard (DOD-STD)-2167A, *Defense System Software Development*, 29 February 1988
- MIL-STD-1521B, *Technical Reviews and Audits for Systems, Equipments, and Computer Software*, 19 December 1985
- MIL-STD-490A, *Specification Practices*, 4 June 1985

- DoD Directive (DoDD) 5000.3-M-4, *Joint Test and Evaluation Procedures Manual*, 1 August 1988
- MIL-STD-1528A, *Manufacturing Management Program*, 9 September 1986
- MIL-STD-1567A, *Work Measurement*, 30 January 1987
- Military Specification (MILSPEC) MIL-Q-9858A, *Quality Program Requirements*, 8 March 1985.

In Appendix I, we present the proposed revisions to military standards, directives, and specifications.

CALS APPLICATION TO THE WEAPON SYSTEM ACQUISITION PROCESS

The following findings and conclusions are summarized from our analysis of the potential CALS impact on weapon system acquisition processes in general and from our detailed analysis of the specific proposed CALS applications presented in this report.

We identified four processes for CALS application:

- Concurrent engineering support
- ECP processing
- TDPs
- Provisioning.

The specific CALS applications we recommend for these processes are presented in Chapter 4.

Applying CALS to the weapon system acquisition process is feasible and offers the potential for high returns on the investment. CALS applications in merely the four processes identified in this study will significantly decrease the workloads in both program management offices and in supporting activities [e.g., inventory control points (ICPs)].

Much of the weapon system support workload is triggered by design changes and work-around solutions to poor designs. While process improvements at the supporting activities would permit incremental reductions in workload, eliminating design changes in the first place would have the greatest effect on workload. Using concurrent engineering promises to reduce ECP volume by 75 percent to 90 percent which should translate directly into corresponding workload reductions for ICPs and for other supporting activities [e.g., those preparing technical manuals (TMs) and conducting training). Better visibility of the remaining ECPs should further reduce workloads as well since work can stop at a supporting activity as soon as a related change is approved by the program manager. These large savings would accrue to the supporting activities without any process improvement on their part.

The large reduction in workload resulting from fewer ECPs may affect the economics of supporting activity process improvements. For example, a solution to streamline supply support activities that is cost-effective at today's processing volumes may not be economical if underlying design changes decrease by 80 percent. Supply support activities should design their process improvements assuming a significantly lower volume of design changes in the future.

Even greater savings are anticipated as next-generation CALS capabilities for data base integration [the integrated weapon system data base (IWSDB)] and product data description [product data exchange using STEP (PDES)/Standard for the Exchange of Product Model Data (STEP)] are developed. More significant process changes will be possible at that time (e.g., the probable elimination of item identification as a separate function since items will be fully described as an integral part of their design). Application of existing CALS technology to improve existing functions would provide the necessary DoD-wide infrastructure and experience to prepare for the next generation of CALS and the next refinement in acquisition and logistics processes.

Prerequisites to Implementation

The most critical prerequisite to effective CALS applications is the presence of a DoD-wide CALS-compliant infrastructure. By this we mean a minimum essential density of workstations, storage facilities, application software, and telecommunications capacity to permit the uninterrupted flow of digital data from contractor to acquisition manager to supporting organizations and back to industry. We found time and again that the benefit of CALS applications drops significantly if the digital data flow hits an "air gap" and has to be converted to hard copy for use or has to be re-entered into another system.

The technology needed for this infrastructure exists today. What is needed is the investment and training required to make CALS capability a routine part of DoD operations. Existing joint CALS programs (e.g., JCALS, JEDMICS, and CITIS) are the backbone of this infrastructure and should include all supporting activities as well as acquisition management activities in developing their functional requirements.

Another reason for emphasizing infrastructure investment is the standardizing influence it can have on CALS requirements in acquisition contracts. Most of the permanent data acquired through a weapon system acquisition contract are for use by the supporting activities over a system's life, rather than by the program management office itself. If the data requirements of supporting activities and the ability of those activities to receive and process that data are established and widely known, program managers will have a better idea of the content and format of data they will have to obtain under contract. That knowledge would help resolve the current difficulty of often applying CALS requirements contract-by-contract based on program manager capabilities rather than ultimate user capabilities. That procedure presents DoD contractors with a wide variety of CALS requirements in solicitations and offers no assurance that the ultimate data users (the supporting activities) will be able to receive and process the data digitally.

A third prerequisite is close coordination with the Joint Logistics Systems Command (JLSC) to ensure that CALS standards and systems are compatible with JLSC-designated standard DoD systems for logistics activities.

Schedule Impacts

A significant responsibility of a program management office and much of its workload entails reviewing and approving contractor decisions and documentation. Numerous complaints about the slow DoD response in this area have been documented. Although our proposed CALS applications focus on review and approval in the design review, ECP, TDP, and provisioning processes, many other processes and their contract data deliverables could benefit from the review-and-approval capability we propose. Functional areas where DoD response could be improved include T&E, integrated logistics support (ILS), and training. CALS allows DoD to be more responsive, and that increased responsiveness reduces the internal costs by shortening review and approval cycles and at the same time reduces contract costs incurred by delays in decisions (e.g., rework and schedule slippage).

Savings Estimates

We limited our review of potential CALS savings to those that would accrue directly to DoD. We did not consider savings that would accrue directly to contractors and eventually be passed on to DoD through lower contract costs.

We conservatively estimate a DoD-wide savings of more than $165 million per year from the proposed CALS applications. Additional DoD-wide savings in the range of $30 million to $40 million per year are considered likely but could not be quantified for this report. Those savings are the result of reduction and elimination of work within functions (e.g., automated indexing of technical data within data repositories) that can be accomplished with existing CALS technology within a relatively short time frame. As integrated data bases and greatly improved telecommunications capability become available, more significant reductions become possible (e.g., consolidation of data repositories themselves). However, it is premature to estimate the magnitude of these future savings.

The absence of many cost or level-of-activity indicators or their inaccessibility, particularly for roll-up to a DoD level, severely hampers our ability to estimate savings. For example, the number of ECPs generated under DoD contracts and the number of design change notices (DCNs) processed by ICPs are not readily available. Without these numbers, it is difficult to impossible to establish specific cost baselines or to measure progress against goals as CALS is implemented. Key cost and level-of-activity indicators should be established.

The savings identified are contingent upon process changes within the functions to which CALS is applied and upon the assumption that personnel reductions will be taken. To the extent that processes do not change or personnel are reassigned to other tasks, estimated dollar savings will not be realized.

From a real-world perspective, program management office staffs have always been relatively lean and ICPs have already taken severe personnel reductions as a result of Defense Management Report Decisions (DMRDs). The productivity improvements achieved through CALS applications will probably help program management offices (PMOs) and ICPs to accomplish their missions better with the people that remain than to allow further personnel reductions. If so, the net dollar savings from CALS applications may be much smaller than estimated here.

As mentioned in Chapter 2, many collateral benefits accrue from implementing CALS applications, and those benefits have not been measured. For example, the multidisciplinary review-and-approval capability proposed to support concurrent engineering could be used to improve almost any review and approval activity in the PMO (e.g., test plans and reports or training outlines and plans, etc.).

Collateral savings are additive to those estimated in this report. In fact, it is nearly impossible to anticipate all the uses to which CALS applications could be put. CALS capabilities are much like a computer operating system. The operating system enables many software applications, but it is impossible to anticipate the value of all the applications that will use it. Decision makers should expect unanticipated benefits (both tangible and intangible) from CALS implementation.

One other savings factor to consider is the cost shift required to realize the life-cycle savings we have estimated. Some processes, particularly in the earlier acquisition phases, may actually experience increased labor costs and delayed schedules because of requirements for wider coordination of design with production and logistics elements. Although that up-front cost is more than offset over the remainder of the life cycle, a short-term view of costs and benefits in the earlier phases could prevent achievement of potential CALS benefits. Incentives and policy need to focus on supporting the long-term view when establishing CALS requirements for early acquisition phases, especially dem/val and EMD.

Investment Requirements

The savings calculated for CALS applications are partially offset by the cost of implementing them. Several types of investment are required to implement these and other CALS applications. First and foremost is the need for a DoD-wide, CALS-compliant infrastructure that permits seamless digital data exchange and processing from the weapon system contractor through the PMO to the supporting activities and back to industry. This modernization is a major effort that will encompass hardware, software, and telecommunications capacity upgrades.

A second type of investment required is modification of specific systems to improve integration (e.g., of the several systems that handle different aspects of ECP processing) or to permit digital data receipt [e.g., Cataloging Tools On-Line (CTOL) which can accept digital images only from its own scanner and not from a digital data file].

A third type of investment is conversion of legacy data. Even if all new and revised data are acquired in CALS-compliant digital format, a tremendous volume of DoD's active technical data already exists on paper, on microform, or in non-CALS digital form. A significant portion of the existing active data must be converted to digital form to realize the benefits of CALS applications. Without systematic conversion of legacy data, dual data processing capabilities will need to operate for an extended period of time (adding to operating costs), and operational complexity will increase as portions of the technical data required are in CALS format while other portions are not.

A fourth type of investment is the operational cost of CITIS and of telecommunications user charges. Many CALS applications anticipate eventual data base integration and consolidation of data repositories. This capability will increase the need for on-line access to remote data bases for technical data.

Estimation of investment costs is extremely complex. Obviously, many of the infrastructure hardware and software costs are included in the major joint CALS programs (JCALS and JEDMICS). These programs are still being converted to joint status and their requirements (and therefore costs) are still being finalized. Some additional hardware and software costs may also be required for specific CALS applications but cannot be determined until JCALS program requirements and individual site surveys can be established to identify the shortfall on an activity-by-activity basis.

Telecommunications modernization is continuing. It would be difficult to estimate the CALS-specific portion of those costs unless specific CALS requirements are approved and installed. CITIS and telecommunications user charges are also still being defined at this time.

Policy Implications

The most important policy implication for CALS applications is that in nearly all cases, CALS is a tool that enables functional managers to improve functional processes. In that sense, what CALS can do in terms of process improvement is tempered by what functional managers believe it should do.

One potential policy consideration for use of CALS applications may be a perceived loss of control over processes. Existing paper-based processes have well-defined safeguards to assure that documents are properly received and not released until approved. With CALS applications and the equivalent of electronic mail access, a much greater opportunity exists for lateral access to documents. While offering greater opportunities for coordination and better decision making, such access also offers the potential for premature or inappropriate access to working documents that have not yet been approved. Adequate controls will need to be installed to persuade functional managers that gains from CALS applications will outweigh potential risks.

Another related consideration for the use of CALS applications is the resistance to cultural and political change. Those processes in which CALS will assist in an essentially human activity will be more difficult to accept than those in which CALS primarily improves system integration. Potential job reclassifications and reorganizations resulting from the process changes could also lead to political resistance. These issues should not prevent implementation, but they do need to be anticipated and resolved.

A third potential consideration is the fact that many of the benefits of CALS applications occur remote from the point of process change/investment. For example, although the life-cycle benefits from supporting concurrent engineering are expected to far offset the cost, many of the benefits of better and more supportable designs accrue in the supporting activities while the costs of greater coordination will fall on the PMO and design contractor(s). Unless the full life-cycle benefits are considered, many CALS applications will likely appear unattractive to those required to implement them.

A fourth potential consideration is the timing of CALS capabilities. Program managers are reluctant to acquire digital data when the receiving activities are unable to process those data, and receiving activities are unwilling to invest in digital processing capabilities until the digital data are available. That situation is aggravated by the lead times involved. (A lag normally occurs between the time program management orders data and the time it receives those data, and a procurement lead time is necessary for supporting activities to acquire systems and train personnel.) Both acquisition programs and supporting activities need a policy that establishes a specific target date and processing environment for receipt and processing of CALS-compliant digital data.

A fifth potential consideration is the uncertainty regarding small business participation in CALS. To the extent that small business is exempted from operating in a CALS environment, DoD will need to operate both CALS and non-CALS systems to interact with small business suppliers. Policy decisions are required in this area to establish the cost structure and operating environment for which CALS applications should be designed.

A final consideration is the need to recognize DLA's increasing role in weapon system support. As it accumulates greater supply support responsibilities, DLA should play an increasing role in weapon system development decisions that have primarily been in the program manager or Service domain. DLA should participate in all policy decisions made as a result of CALS applications that affect its operations.

CALS Data Exchange Standards

Data exchange standards are the foundation of CALS and are needed if we are to meet the CALS goals. For standards to work, they must be stable and adopted by industry; for standards to be affordable, they need to be adopted for off-the-shelf products from multiple vendors. Vendors will only support data exchange standards when they see a clear and strong market demand, and sufficient demand only occurs when standards add value to commercial as well as Government products. Development policy for CALS data exchange standards must reflect these realities if CALS is to realize cost benefits. Some standards adopted by CALS fully meet these criteria now; others do not.

Industry consensus is that weapon system program managers have been slow to adopt CALS standards. Appendix H reviews CALS standards and related standards and makes recommendations on which ones to encourage in the near term and how to do it based on their stability, functionality, affordability, and industry support.

Immediate benefits from CALS depend on the use of technology and standards that are widely used today. The CALS Phase I standards are largely in line with off-the-shelf commercial products. Those standards, however, need to be managed.

Additional near-term benefits can be gained by judicious application of new, but already rapidly proliferating, standards for electronic management and presentation of technical information. The JCALS and interactive electronic technical manual (IETM) activities are examples. The risk involved in these activities can be decreased with joint participation and management as well as with additional research, development, and testing as described in the action items.

Active coordination with industrial activities is required to gain the full benefits of the standards in the shortest time frame.

Proposed Implementation Plans

Because the infrastructure needs to be modernized, policy revised, and other prerequisites completed, most CALS applications cannot be implemented throughout DoD until 1994 or beyond. Shorter term implementations would suffer from unbalanced digital processing capabilities among activities, large-scale directive and policy deviations, program-specific and other non-CALS-compliant solutions, and other negative effects that would offset most benefits.

In spite of the relatively long implementation time frames, many actions can and should be started soon to begin the implementation process. Near-term actions include supporting progress on infrastructure programs and initiating contacts with functional managers to propose specific, potential CALS applications in their functional areas.

Implementation should not include further CALS Phase I prototyping. Previous prototypes have proven CALS Phase I concepts (i.e., digital data exchange) but have also generally developed program-specific solutions that use digital, but not CALS-compliant, data exchange. The challenge now is to develop DoD-wide solutions whose implementation requires little or no trading partner negotiations, standardization of hardware/software, or policy variances. It is doubtful that further weapon system program CALS Phase I prototypes will add value to that effort. Future prototyping should focus primarily on developing data base integration and product data description standards (CALS Phase II).

CALS Incentives and Enforcement

Incentives

Contractors have a variety of incentives for using CALS. They include incentive contracts, the Industrial Modernization Incentives Program (IMIP), value engineering (VE), and the manufacturing technology (MANTECH) program. The Science Applications International Corporation (SAIC) performed a detailed review of these incentives in relation to CALS,[1] and they are also covered in Appendix A of DoD Military Handbook MIL-HDBK-59A, *Department of Defense Computer-aided Acquisition and Logistics Support (CALS) Program Implementation Guide*, 28 September 1990. Of these methods, cost-plus-incentive-fee (CPIF) and cost-plus-award-fee (CPAF) contracts, along with VE, will likely be the most effective methods for providing the contractor with an incentive.

The CPIF and CPAF contracts can be used in all phases of the acquisition process and would be especially valuable in the early phases where concurrent engineering and CALS would be used. Those contracts motivate contractors to reduce their costs to earn a higher fee, and CALS is one of the tools that contractors could use to help reduce costs. The use of CALS can be further encouraged by giving it more weight as a proposal evaluation factor in Section M of the solicitation.

Value engineering can be applied voluntarily or it can be mandated. VE cost reduction efforts can be applied to equipment, manufacturing methods, products, and services. It offers both acquisition and collateral savings. Collateral savings are particularly relevant to CALS because of their impact on logistics, maintenance, and other program costs.

The other incentives, IMIP and the MANTECH program, are less likely to be effective in motivating the contractor to use CALS. Those programs, while they could be applied to CALS, have typically focused on manufacturing issues such as advanced manufacturing processes, facilities, equipment, quality, etc. Additionally, IMIP imposes a greater administrative burden upon the contractor than the other incentives, while the MANTECH program is primarily targeted at manufacturing technologies that private industry is unable or unwilling to fund. DoD may discontinue IMIP after 1994, and it has proposed decreased funding for the MANTECH program in recent years despite Congress's increased interest in the program.

The incentives cited thus far are merely the formal ones. Several informal or systemic factors would be motivational. For example, contractors will become more interested in CALS once the CALS data exchange standards are finalized. Those

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[1]*Incentives and Funding Mechanisms*, CALS QRTO 1060, SAIC, McLean, Va, June 1990.

standards will help software firms build translators for the various computer-aided design (CAD) packages so that technical data can be transmitted in a CALS-compliant format. Progress on JCALS will help demonstrate to industry that DoD is serious about joint Service standards. Government contractors that compete with each other or with other private-sector firms will also be motivated by general competitive pressures to perform concurrent engineering and to use CALS. The overall level and cost of technology and infrastructure will also delineate the type of CALS activities that contractors are willing to undertake.

The nature of concurrent engineering and CALS often requires that a large investment be made early in the program. While there are short-term benefits, most benefits will probably occur after production. New incentives that reward contractors for those long-term benefits would help to motivate contractors to pursue innovative CALS solutions. Because some of the long-term CALS benefits will accrue in support of activities outside the program office, those activities should help fund CALS initiatives early in the program.

In addition to contractor incentives, the program manager should also receive incentives for utilizing CALS in weapon system programs. Incentive contracts and the VE program are incentives to the program manager as well as the contractor because savings are shared by the Government. CALS usage can also be made a factor in the program manager's performance appraisal. An incentive award program sponsored by the CALS office would also help to stimulate CALS usage in weapon systems. Unfortunately, DoDD 5120.16, *Department of Defense Incentive Awards Program: Policies and Standards*, 15 July 1974, prohibits monetary awards to military personnel for superior job performance. Perhaps a mix of cash awards for civilian personnel and other recognition (promotion, favorable performance rating, etc.) for military personnel could be devised to help provide incentives and promote the use of CALS by program managers.

Program managers will be motivated to pursue CALS initiatives if they are convinced that it would help them manage their program better and reduce costs. Short-term benefits are therefore more important to the program manager than the long-term benefits, which will affect someone else. DoD should identify and measure those short-term benefits in programs currently using CALS or other digital data technology and then disseminate the information so that other program managers become convinced of the advantages of CALS. The identification of program cost drivers, CALS metrics, and the development of a CALS business case will be of great help in documenting benefits.

Enforcement

In 1988, the Deputy Secretary of Defense issued a memorandum to the Military Services and DLA requiring that CALS standards be included in plans for new weapon systems and related major equipment items. That initial guidance has been superseded by Part 6, Section N, of DoD Instruction (DoDI) 5000.2 *Defense Acquisition Management Policies and Procedures*, 23 February 1991. As a practical matter, enforcement has been difficult because most of the CALS standards have not yet been finalized in the 4 years since the Deputy Secretary's memorandum. The most important steps toward enforcing CALS are finalizing the CALS standards and providing a sufficient infrastructure for using the data. Until these steps have been completed, implementing language must necessarily be somewhat loose in order to give the program manager the flexibility to work around CALS problems. Unfortunately, this looseness can also limit the application of CALS in situations in which the standards are sufficient. Much of the guidance in Part 6, Section N, of DoDI 5000.2, and in MIL-HDBK-59A uses the term "should" when referring to CALS implementation. That usage gives the impression that CALS is desired but not absolutely required. CALS guidance in Part 6, Section N, should state that MIL-HDBK-59A contains detailed implementing guidance and *shall* be used.

Acquisition guidance elsewhere in DoDI 5000.2 should also be strengthened to promote the use of CALS. Concurrent engineering is probably the best technique for reducing cost and improving quality in weapon systems acquisitions. CALS will greatly facilitate the use of concurrent engineering by contractors and will allow the Government to better manage the process. Both techniques are mentioned in DoDI 5000.2, but the concurrent engineering/CALS connection is important enough to be separately referenced as a Defense Acquisition Board (DAB) criterion. The use of concurrent engineering/CALS should be established as an exit criterion for the concept exploration and definition, dem/val, EMD, and production phases of the acquisition process. The following changes should be made to DoDI 5000.2:

- For the concept exploration and definition phase, Paragraph b.(1)(b) on Page 3-7 should be modified to include identification of opportunities for digital data exchange using CALS.
- For the dem/val phase, Paragraph d.(1) on Page 3-13 should be modified to state that maximum use of concurrent engineering and CALS will be made. A concurrent engineering approach and a CALS implementation plan should be added to the list of minimum required accomplishments specified on Page 3-14.
- For the EMD phase, Paragraph f.(1) on Page 3-20 should be modified to include concurrent engineering and CALS as risk-reducing techniques. The minimum required accomplishments specified on Page 3-21 should be revised to include the use of concurrent engineering and CALS.
- For the production and deployment phase, the minimum required accomplishments specified on Page 3-27 should be revised to reflect the use of CALS for configuration management and for implementing support plans.

The wording at Defense FAR (Federal Acquisition Regulation) Supplement (DFARS) 207.105(b)(12)(S-70) should be strengthened to state that acquisition plans for weapon systems shall include a CALS implementation plan rather than merely describe the extent of CALS implementation. Similarly, solicitations should require a CALS implementation plan by the contractor, and the Government should favorably weigh such plans during evaluation of offers. Internal Government review and approval of acquisition plans and solicitations should be based in part upon the inclusion of CALS standards and requirements.

Major systems contracts also require the inclusion of DFARS clause 252.210-7003, *Acquisition Streamlining.* That clause requires the contractor to submit acquisition streamlining recommendations in accordance with the contract's statement of work. Its main purpose is to have the contractor identify over-specification and non-cost-effective requirements, but it could conceivably be used as a vehicle to encourage the contractor to submit recommendations on CALS requirements as well.

CALS Guidance to Program Managers

High-level CALS guidance is provided to program managers through DoDI 5000.2, Part 6, Section N, while detailed implementation guidance is provided in MIL-HDBK-59A, which is scheduled for revision.

The handbook contains a wealth of CALS information for program managers, but its organization is not conducive to easy reading. We recommend that the appendices be rewritten as chapters since the appendices constitute most of the handbook. This would avoid the repetitive numbering scheme in each appendix and make it easier to find a passage. We believe that a detailed step-by-step "how to do it" approach would be more valuable to program mangers than the existing topical organization. The handbook should be updated to include coverage on JCALS and JEDMICS. There should be guidance on how and where to retrofit programs with CALS, and a subject index would be useful.

Our specific comments on changes to MIL-HDBK-59A are at Appendix J.

CALS and the "New" Weapon System Acquisition Strategy

The DoD's new acquisition strategy is to develop a new technology, hold it "on the shelf" until it is needed, then go into production. Since many benefits from CALS applications accrue in the production and operation and support phases of the life cycle, a legitimate question is raised about the value of CALS under this new strategy. This subsection addresses that question.

Recent world events including the breakup of the Warsaw Pact and the dissolution of the Soviet Union, have resulted in a downsizing of our armed forces. In addition to a reduction in DoD manpower, acquisition of new weapon systems is also being reduced. Consequently, we can expect a greater reliance on existing weapon systems for longer periods of time. The need to acquire fewer new weapon systems will affect the production capacity of the defense industry and require increased dependence on new technology if we are to maintain our warfighting proficiency. Reliance on superior technology and the ability to rapidly revive production lines are the key elements of DoD's new acquisition strategy.[2]

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[2]Donald J. Atwood, Jr., Deputy Secretary of Defense, testimony to the House Armed Services Committee, 28 April 1992.

Traditionally, the acquisition process has been driven by the urgency to replace weapon systems with systems that could counter those developed by our adversaries. Since that urgency has diminished, rapid development of new weapon systems with associated high-risk concurrent production will no longer be a driving force in the acquisition process. Instead, the emphasis will be placed on developing and demonstrating superior advanced technologies. Once the utility of a technology has been firmly established, it may be introduced into a new system, incorporated in an existing system, or most likely, placed "on the shelf" for future use. Placing the technology on the shelf will create production gaps in the defense industry and require CALS applications to be fully successful.

The new acquisition strategy relies on the Defense Science and Technology Program to maintain technological superiority and requires the participation and coordinated efforts of industry, academia, and the Services. CALS data sharing capabilities can facilitate electronic documentation and access to new technology information by the universities, Government Laboratories, small contractors, and the laboratories of major contractors. Thus, it will promote an increased knowledge base and provide a means of oversight to ensure duplicative efforts are avoided. Additionally, demonstrated technology, which may remain on the shelf for years before going into production, will need to be revived when the time comes to replace aging systems with cost-effective alternatives. CALS will be instrumental in "dusting off" this technology and taking it to the next step.

The CALS program can contribute to the success of the new acquisition strategy by providing information essential to reconstituting manufacturing facilities and processes. DoD plans to identify and maintain those critical elements of the defense production base that could not be reconstituted for a reasonable cost or in a reasonable time. In some cases, costly actions to maintain these elements, including directed procurement, may be required. Through its electronic document and retrieval capability, CALS can assist in facility and manufacturing process start-up or ramp-up by identifying lead times, major subcontractors and vendors, tooling, equipment layouts, test procedures, configurations, system integration information, etc. The availability of this information can aid the reconstitution process even if the human continuity factor is missing; therefore, costly efforts to maintain this capability may be minimized.

Perhaps the greatest CALS benefit to the new acquisition strategy is cost reduction. We can expect the acquisition of fewer new weapon systems to result in a corresponding decrease in the defense acquisition budget. Introduction of CALS applications into the acquisition process can promote efficiencies that translate to cost savings. As an example, application of concurrent engineering approaches in the development phase can result in a design that is more producible and of higher quality, thereby requiring fewer changes and less testing. CALS applications in support of concurrent engineering can reduce the time required to perform various design functions, to document and analyze technical decisions, to prepare and review reports, to produce and analyze technical data, and to make the transition from development to production.

Savings generated from CALS applications will stretch limited financial resources and enable more technology development, investments in advanced manufacturing processes and production of technologies that otherwise might never be fielded.

In summary, we believe that CALS remains a reasonable investment even under the new acquisition strategy for the following reasons:

- Emphasis is likely to shift to system modifications as weapon system life spans increase. These modifications will be developed, enter production, and affect the operational and support cost of fielded weapon systems. These programs will benefit from CALS in the same manner as traditional programs that go directly into production.

- Those systems and technologies that are put "on the shelf" are likely to need some degree of redesign and redevelopment before they can enter production. Using CALS during original development will help ensure that systems and technologies that are put on the shelf are producible and will require minimal lead time to production if the system or technology is needed. CALS will be just as valuable accelerating redevelopment before production begins as it is in original development. In fact, CALS may be critical to the successful execution of the new strategy since, with the passage of time, new contractors may be involved and they will need to obtain technical data rapidly and effectively in order to produce and field the system in a timely manner.

CHAPTER 4

CALS APPLICATIONS

RECOMMENDED CALS APPLICATIONS FOR WEAPON SYSTEM ACQUISITION

The recommended CALS applications for weapon system acquisition fall within four areas: concurrent engineering support, ECP processing, TDPs, and provisioning. We recommend two or three CALS applications in each area.

Concurrent Engineering Support

Introduction

Design is the weapon system acquisition activity with the most pervasive impact on life-cycle costs. While the design process is primarily a contractor function, the Government plays a role in reviewing and approving designs and in enforcing the use of standard and/or existing parts. Contractors are implementing concurrent engineering to improve the quality of initial designs and are changing their procedures as a result. DoD procedures must also change to take full advantage of and to support contractor concurrent engineering processes. CALS can help improve DoD support of concurrent engineering and help contractors make better parts selection decisions during design.

Concurrent engineering is the integration of systems engineering, design engineering, manufacturing, testing, support, and other functional areas during a product's development. It differs from the traditional engineering approach in which product information flows sequentially from design to manufacturing to product support. In traditional engineering, manufacturing and supportability issues are often inadequately addressed during product design. As a result, costly fixes and workarounds are needed and lower quality, more design changes, and longer product development cycles must be faced. About 80 to 90 percent of all production, distribution, and support costs are locked in once a design baseline is established. No amount of skill or wisdom will significantly alter the committed costs by more than 5 to 10 percent after the design is released to manufacturing.[1]

A growing number of firms are using concurrent engineering to reduce development time and increase product quality. It has significantly improved product design and system integration and reduced engineering changes after the design phase. It is most beneficial when it is begun as early as possible in the development process. Time and cost may actually increase in the early stages of the development cycle as more players are brought into the decision-making process. However, the benefits of concurrent engineering have a ripple effect throughout the rest of the development process, resulting in lower overall development time and cost.

In the DoD weapons acquisition process, concurrent engineering emphasis has been directed at the contractor since the contractor is responsible for designing and producing the product. However, the Government also performs a significant number of activities that could benefit from a concurrent management approach. The DoD acquisition model indicates that 42 percent of its 840 activities are primarily document management activities. These activities include developing, preparing, reviewing, updating, and approving documents. The DoD program management function and the Services are responsible for 38 percent and 23 percent of the document management activities, respectively, while the contractor is responsible for 19 percent. The remaining 20 percent is distributed among other Government activities, Laboratories, users, OSD, and Congress.

The CALS program can play a major role in linking multidisciplinary design review teams of DoD personnel more effectively in a form of "concurrent program management" patterned after concurrent engineering. Such a multidisciplinary team can respond better to design issues requiring DoD decisions. The emphasis here is on more responsive action under existing DoD responsibilities and not on increasing DoD oversight beyond that already in place.

Another design activity on which CALS can have a major impact is parts selection. A design engineer first establishes a design concept and then selects specific parts for the design. The DoD Parts Control Program requires the designer to select parts that conform to military standards whenever possible and when not

[1]John Shewchuk, "Life Cycle Thinking," *CMA Magazine*, May 1992, pp. 36 – 46.

possible, to request approval to use nonstandard parts. The appropriate Military Parts Control Advisory Group (MPCAG) reviews each nonstandard parts request and recommends to the program manager whether the request should be approved or denied. This review process can cause schedule delays and incurs processing costs.

Designers currently have a limited ability to search existing items for one that matches the design requirements. As a result, the designer may choose a nonstandard part instead of an existing item. A General Accounting Office audit showed, however, that in spite of MPCAG review, a large percentage of MPCAG recommendations were never implemented in the final design.[2] CALS would help to reduce use of nonstandard parts by providing the contractor with wider access to characteristic search data.

We believe that, given the appropriate parts control information, contractors are usually in the best position to determine suitability of standard parts for use in design and that adequate control is possible to ensure that contractors use standard parts to the maximum extent possible. DoD's role, we believe, is to set parts control policy (e.g., use a standard part rather than a nonstandard part when the standard part will do the job) and to audit contractor decisions rather than require pre-approval from DoD to use nonstandard parts. We recommend that delegation of parts control decision authority to contractors (subject to DoD audit) be tested. If such delegation is feasible, processing costs and schedule delays related to parts control approvals can be significantly reduced.

Beyond the issue of choosing a standard part is the issue of choosing a "supportable" part. Under today's procedures, if two or more "standard" parts are suitable for use in a given design, each is considered equally for use. Often, however, standardization decisions have been made for similar National Stock Number (NSN) items that group them in one "family." All items in the family are considered interchangeable or substitutable although one item is selected as the preferred item. Stocks of the other items in the family are used until they are exhausted, and after that only the preferred item is stocked. Giving designers information about which items in a family are preferred would help ensure that the parts making up the weapon system are the most supportable items available. We believe contractors should be given access to the DoD supply system (through CALS) and should be given

[2]General Accounting Office Audit Report, *Management Review: Progress and Challenges at DLA*, April 1986.

responsibility for selecting a suitable standard part for parts control as well as the standard part that is preferred (if standardization families exist). This procedure would save considerable downstream costs for design changes and backorders.

We propose two CALS applications in support of concurrent engineering: providing concurrent program management for supporting the contractor's concurrent engineering activities and providing better contractor access to Government supply system data.

Application 1: Concurrent Program Management

Recommendations. We offer the following two recommendations with regard to concurrent program management:

- *DoD PMOs should actively support contractors' concurrent engineering efforts by setting up similar DoD multidisciplinary teams and processes for oversight, review, and approval of contractors' work and other internal PMO functions.* CALS offers the capability to make technical decisions, with appropriate program manager oversight, as issues arise. This capability would improve the responsiveness of DoD technical reviews by preventing decisions from being delayed until a formal in-process review (IPR). Design reviews could then be used as "big picture" progress checks rather than as reviews of massive amounts of design detail.
- *Establish appropriate "command and control" procedures for reviewing digital design data.* Concurrent engineering encourages sharing "raw" or work-in-process data within and across organizations, and CALS provides the means to do so. Sharing these data is valuable because it may help identify problems or issues earlier in the process. However, these data need to be clearly identified to distinguish them from the current design baseline. Concurrent engineering and CALS also encourage decision making to be delegated to lower levels. The appropriate controls must be built into any electronic review/approval system to ensure adequate management oversight of technical decisions.

Prerequisites. To fully integrate the Government multidisciplinary teams and provide adequate electronic links to contractors in a concurrent engineering environment, the following prerequisites are necessary:

- *Integrated weapon system data base implementation.* The IWSDB is a long-term CALS objective that places all relevant weapon system data into one logical data base. The data may be physically stored in many different data bases, but through integration, the data bases are linked. The IWSDB will make data instantly available to all users, thereby avoiding the delays that occur when data are passed sequentially from user to user. It will also facilitate simultaneous access to the wide variety of data a multidisciplinary team will need to review.

- *Contractor Integrated Technical Information Service implementation.* CITIS is the mechanism that will allow the Government and other approved users to access contractor-maintained data bases of weapon system information. CITIS optional services are expected to include the capability for on-line review and approvals.

- *Telecommunications infrastructure.* An adequate telecommunications network is needed between contractors and program offices, and between program offices and other Government functional activities for the full benefits of this recommendation to be realized. The network must be able to handle simultaneous users without a degradation in performance. If digital drawings need to be sent over the network, adequate capacity and/or data compression must exist. Large portions of the existing network lack the capacity to transmit drawings and other graphic data with sufficient speed.

- *Cultural change.* The use of concurrent engineering practices and the sharing of information that was previously kept within individual functional areas requires added trust between DoD activities. Sharing information will help to reinforce the team approach, but strong leadership from the program manager is required. Short periods of physical collocation at the beginning of the program can help to build relationships and trust that could then be continued electronically.

Schedule Impacts. Implementation of the concurrent program management recommendations would require devoting increased time to early phases of the program. More participants would be involved in design and tradeoff analyses. This additional time is more than offset, however, by fewer and faster program reviews, less rework, and higher quality.

Savings Impacts. Some of the direct benefits of a concurrent program management process are as follows:

- *Fewer formal technical in-process reviews.* CALS will allow technical issues to be addressed on-line as they occur. As a result, decisions can be made as design progresses, and the program manager can determine progress at any point.

- *Design reviews can become "big picture" events.* Design reviews often consist in large part of walk-throughs of massive amounts of design detail to bring the program manager and the management team "up to speed" on the system design. If DoD multidisciplinary teams work concurrently with each other and with contractor teams throughout the design process, the program manager and the management team will be more familiar with the design and will have already made many key design decisions required of them. Formal design reviews can then focus on big picture aspects of the design (e.g., satisfaction of overall performance and cost requirements). Design reviews can be shorter and smaller and major issues are less likely to be lost in a sea of details.

- *A faster design process.* Because CALS will facilitate as-you-go decision making, the design process will not have to wait for a formal IPR. CALS will also encourage simultaneous rather than sequential reviews, which will speed the process.
- *Fewer premature "lock-ins" on design issues.* Delays in resolving design issues can "lock-in" the program manager to the contractor's proposal when the contractor proceeds to design around the problem before a decision has been made. By the time the decision is made, the cost to "undo" the change is often so great in terms of redesigning other parts of the system that the program manager has little choice but to approve the ECP. Earlier review and approval of ECPs minimizes the extent of such lock-in and gives the program manager more room to consider alternatives.

We have seen many documented examples from industry that justify concurrent engineering approaches to product development. However, only a few cases document savings directly attributable to a specific initiative, such as use of multidisciplinary teams, or use of a common data base. Most savings occur because a variety of concurrent engineering tools and techniques are used. If the Government were to use some of those tools and techniques during its program management process, it, too, should see benefits in overall schedule and cost savings similar to the contractor's. Because contractor and Government activities differ in many cases, an extrapolation of benefits from cited industry examples is inexact. Also, the synergistic effect of contractor and Government implementation of concurrent engineering management techniques is not yet known.

We can estimate the benefits to DoD of this recommendation on the basis of program data in the acquisition model data base. A sample of 18 key Government review-and-approval activities was extracted for missile programs. We took those activities from the EMD phase of the model and included activities such as review of the design-to-cost/life-cycle cost analysis, approval of the logistics support analysis plan, conducting the preliminary design review, and conducting the critical design review. We calculated the average elapsed time and the number of manweeks expended and found that the 18 activities took 484 weeks and 308 manweeks, respectively. Applying a 10 percent savings factor would reduce total elapsed time by 48 weeks and total applied time by 31 manweeks for these 18 activities. We believe the 10 percent factor is conservative based upon the concurrent engineering, CALS, and CALS-like savings examples from Government and industry presented in Appendix K.

Investment Requirements. Multidisciplinary team members would need workstations and a network to link them. Although not a net additional cost, some costs would occur earlier in the program because production and logistics members become involved much earlier in the acquisition life cycle.

Policy/Regulatory Implications. The use of concurrent program management will require revisions to the following documents:

- DoDD 4245.7-M, *Transition from Development to Production,* 1 September 1985, including its coverage on concurrent engineering and CALS. In the introduction, CALS and concurrent engineering should be mentioned as risk-reducing tools. In Chapter 3, design templates should be updated to include CALS and concurrent engineering where appropriate, especially templates on design policy, process, and analysis; CAD; design reviews; and design release. CALS should also be cited in Chapter 8 – *Logistics*, in templates for logistics support analysis, training materials and equipment, and technical manuals.
- DoDI 5000.2, *Defense Acquisition Management Policies and Procedures*, Part 6, Section A, Subsection 3.c.; "Technical Discipline Integration," to require the use of CALS specifically as an integration tool for supporting concurrent engineering. Part 6, Section N, Subsection 3.f., should also be revised to require the delivery of technical data in CALS-compliant format.
- MIL-STD-1521B, *Technical Reviews and Audits for Systems, Equipments, and Computer Software*, to allow technical reviews and audits to be conducted on-line electronically. In particular, the program manager's technical decisions made on an as-you-go basis following multidisciplinary team review should carry as much weight as decisions originating in formal design reviews. If as-you-go decisions are routinely second-guessed, the value of using the concurrent program management approach would be greatly reduced.

Proposed Implementation Plan. The DoD CALS office should propose this recommendation to the Under Secretary of Defense for Acquisition and the Director of Defense Research and Engineering. If they concur, infrastructure requirements for multidisciplinary teams should be determined and included in JCALS, JEDMICS, or other modernization programs. Policy changes should be timed to coincide with infrastructure capability. Once policy guidance is issued, program management offices would need to reorganize to varying degrees to facilitate the multidisciplinary effort. Although full implementation is not expected prior to 1998, some interim implementations may be possible as early as 1994 using magnetic media and existing local area networks (LANs) (see Figure 4-1).

Application 2: Contractor Access to DoD Supply System Data

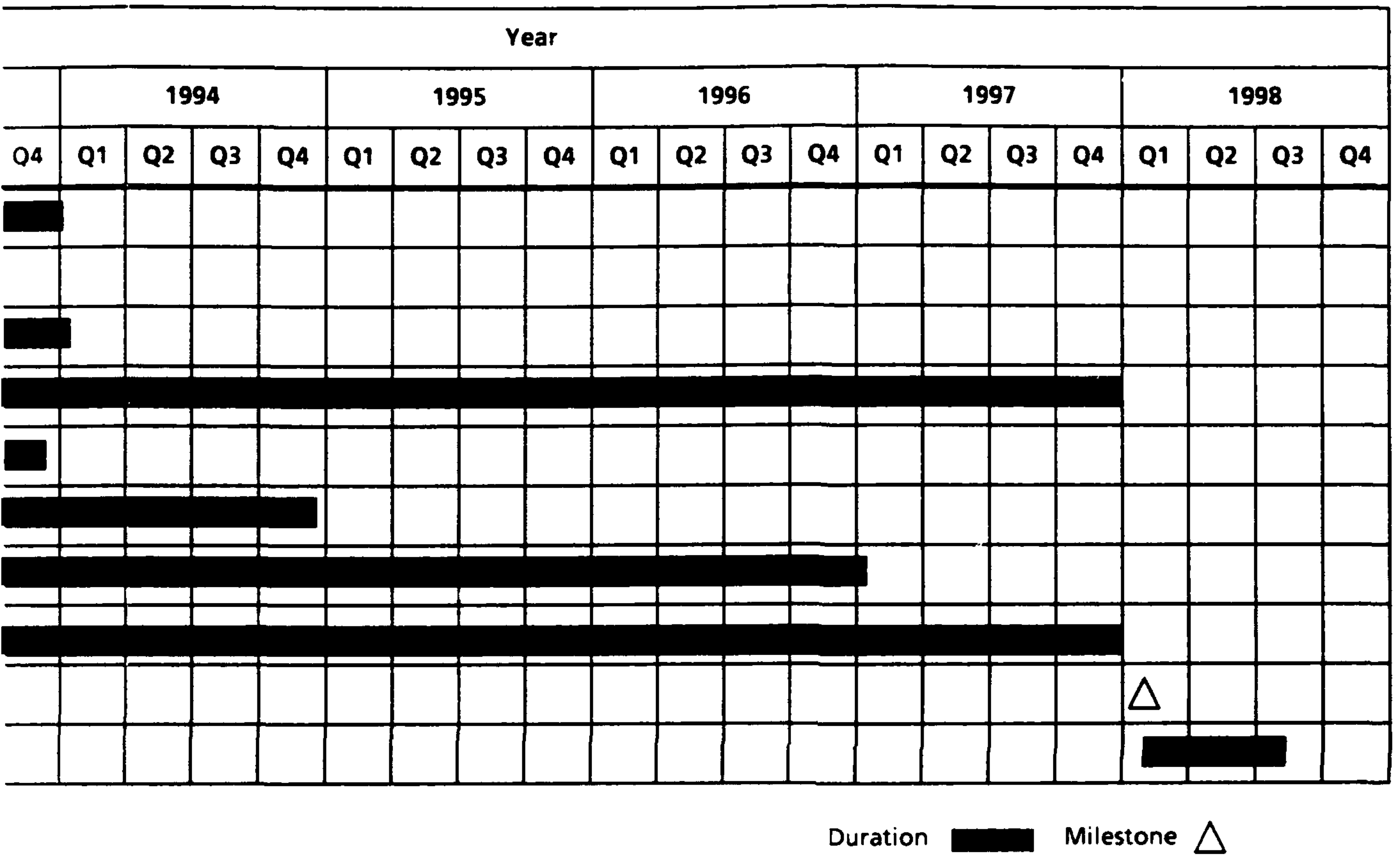
Recommendations. We make the following two recommendations relative to contractor access to DoD supply system data:

- *Give contractors electronic access to tools that improve searches for parts characteristics.* Today's designers have limited readily available information for selecting parts for their weapon system designs. As a result, they generate nonstandard parts requests because they are not aware of the existence of a suitable standard part. Even when designers identify suitable standard parts, however, they do not have enough visibility to know which of the existing parts is most preferred in the supply system. Under this recommendation, designers would be able to search the data base of NSN items quickly using systems like the Logistics Remote User Network (LOGRUN) to identify items that meet such design requirements as weight, size, and strength. If they find parts that meet design requirements, they can use those parts to avoid the cost of designing new items for introduction into the supply system. Information about standard (or preferred) items would also be available to minimize the cost of using parts in the weapon system design that are being phased out of the supply system. If no NSNs can be used in the design, the user has access to the Military Parts Control Automated Support System (MPCASS) to identify whether the part required is available under existing military specifications and standards.
- *Test the delegation of parts control decisions to contractors.* This test would determine whether contractors who are provided with the same tools that DoD parts control personnel use would reach the same parts control decisions. The contractor would apply parts control policy in selecting parts for the weapon system design and document the rationale for all selection of nonstandard parts. The Government would determine parts control policy and the extent of parts control delegation. Contractor compliance could be verified by auditing a sample of their decisions. That audit should prevent contractors from deliberately selecting nonstandard or proprietary items for the design.

Task	Action office(s)	1992	1993				1994		
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q
Revise design review policy									
Recommend policy changes	DoD CALS								
Change policy (MIL-STD-1521; DoDI 5000.2)	DDR&E, USD(A)								
Upgrade DoD infrastructure									
Upgrade PMO workstations and networks	Program Managers								
Implement CITIS	DoD CALS								
Upgrade telecommunications capabilities	DISA								
Implement IWSDB	DoD CALS, JCALS								
Implement application									
Reorganize PMOs	Program Managers								

Note: DDR&E = Director of Defense Research and Engineering; USD(A) = Under Secretary of Defense (Acquisition); DISA = Defense Information Systems

FIG. 4-1. CONCURRENT PROGRAM



-se information Systems Agency.

RRENT PROGRAM MANAGEMENT

Prerequisites. To ensure contractors have access to DoD supply system data, the following prerequisites are necessary:

- *Contractors must have electronic access to supply system and parts characteristics tools such as LOGRUN and MPCASS.*
- *The Government must provide training in the use of the supply system and parts characteristics tools.* Contractor personnel would need to know how to use the tools to select parts and apply parts control policy during the design phase. Government parts control personnel would need training in how to effectively audit contractor decisions.

Schedule Impacts. Time would be saved in the design process since contractors could make the parts control decisions and proceed with the design without waiting for Government approval in most cases. Several weeks are now required to review a nonstandard parts request.

Savings Impacts. Some of the direct benefits of contractor access to DoD supply system data are as follows:

- *Reduced inventory cost.* The annual cost of maintaining a single item in inventory has been estimated at $165 in 1986.[3] That amount, in 1991 dollars, becomes $198. Approximately 110,000 new items are added to the inventory each year, and about 52 percent of those items are stocked. If improved parts control tools such as LOGRUN and MPCASS can reduce the number of new items entering the inventory by 5 percent (5,500 items), the annual DoD-wide savings would be $566,000.[4]
- *Reduced design documentation cost.* Previous research has shown that the use of standard parts in new designs saves from $500 to $2,000 per part in initial documentation costs. Based on the estimated reduction of 5 percent of new parts, DoD would save a minimum of $2.75 million per year on initial documentation costs.
- *Reduced costs for qualifying new vendors.* The costs of qualifying vendors to manufacture new parts competitively is estimated at $4,500 to $25,000 per part. Based upon the estimated 5 percent reduction in new parts, the minimum DoD-wide savings would be $24.7 million.
- *Reduced number of DoD parts control personnel.* The number of parts control personnel can be reduced if the contractor assumes most of the parts control responsibilities. The amount of reduction will depend upon the

[3]James E. Diene. *The Feasibility of Using a Data Base Management System to Aid Piece Part Standardization and Substitution*, Air Force Institute of Technology, September 1986.

[4]5,500 x 0.52 = 2,860 fewer stocked items x $198 holding cost.

amount of responsibility delegated to the contractor and the extent to which the Government will have to audit and sample contractor parts control decisions to ensure policy compliance.

- *Reduced the number of nonstandard parts would improve supply support.* We know the procurement and production lead times of items already in the supply system. New items, however, have uncertain lead times and only a few suppliers may be available.
- *Lower supply support costs.* Nonstandard parts may not be competitively priced if they are available from only one supplier. Lower production runs can also increase unit costs. Standard parts are more likely to have multiple sources, be competitively priced, and have a demand that prevents uneconomic production quantities.
- *Faster distribution of technical data packages.* The use of standard parts will speed the contractor's preparation of TDPs because necessary technical data for those items would already be available.

Investment Requirements. Investments would be required in two areas to implement contractor access to DoD supply system data:

- *Parts control tools.* Electronic access to tools such as LOGRUN, MPCASS, and supply status data would need to be provided to contractors who would have to be trained in how to use the tools.
- *Higher contract costs.* The contractor may increase proposal costs if required to take on more of the parts control function now handled by the Government. Currently, the contractor can quickly prepare a nonstandard parts request and leave the burden for researching the item to the Government. These investment costs, however, may be offset by a corresponding reduction in the Government's parts control function.

Policy/Regulatory Implications. Ensuring contractor access to DoD supply system data will require revisions to the following documents:

- MIL-STD-965A, *Parts Control Program,* 24 July 1989, to delegate parts control responsibilities to the contractor. A determination would be needed on how much delegation of parts control decisions to allow. For example, the Government may wish to retain control over certain technologies, standards, or specifications. A plan for effectively auditing the contractor's decisions is also required.
- DoDI 5000.2, *Defense Acquisition Management Policies and Procedures,* Part 6, Section R, Subsection 2, "Policies," to state that the contractor is responsible for implementing parts control policy. Revise Subsection 3.a.(2) by adding a paragraph that states that the MPCAGs will establish the

extent of parts control delegation to contractors and will establish audit and review requirements to ensure contractor compliance.

Proposed Implementation Plan. LOGRUN, MPCASS, and other supply system interfaces would be modified by DLA as necessary to give the contractor electronic access. Installation and training at contractor facilities would be required. The parts control delegation test would be conducted on a weapon system acquisition program entering the design phase. If the test proves the feasibility of delegating parts control decisions to contractors, appropriate policy changes and contract modifications would be made. Finally, MPCAGs would be reorganized to reflect the process changes once the parts control delegation was implemented. Implementation is estimated in late 1994 (see Figure 4-2).

Engineering Change Proposal Processing

Introduction

Even with the best implementation of concurrent engineering, many ECPs will still be required because of requirements changes, technological problems, funding changes, etc. Delays in ECP approvals have been documented as a serious acquisition problem. Processing ECPs is also a good example of the kind of high-volume, repetitive processing action in which significant savings can be obtained even with small process improvements. CALS can offer significant improvements in the ECP process in terms of faster review cycles and downstream cost savings.

Configuration management is a discipline that identifies the functional and performance characteristics of an item or system and records and controls them. It begins in the EMD phase of the acquisition process and is performed throughout the life cycle of the item/system. Proper logistic support, maintenance, training, and operational employment of a system are dependent on knowing its specific configuration at all times. For example, not knowing the type of air conditioners installed in the M-1 tanks used in Operation Desert Storm could have resulted in the wrong spare parts being available for repairs or in improper maintenance procedures being used, and either could have resulted in a degraded weapon system capability.

Contractors develop ECPs to describe, justify, and document proposed changes to previously approved system design baselines. ECPs are submitted to the Government for review and approval. An ECP addresses all areas affected by the

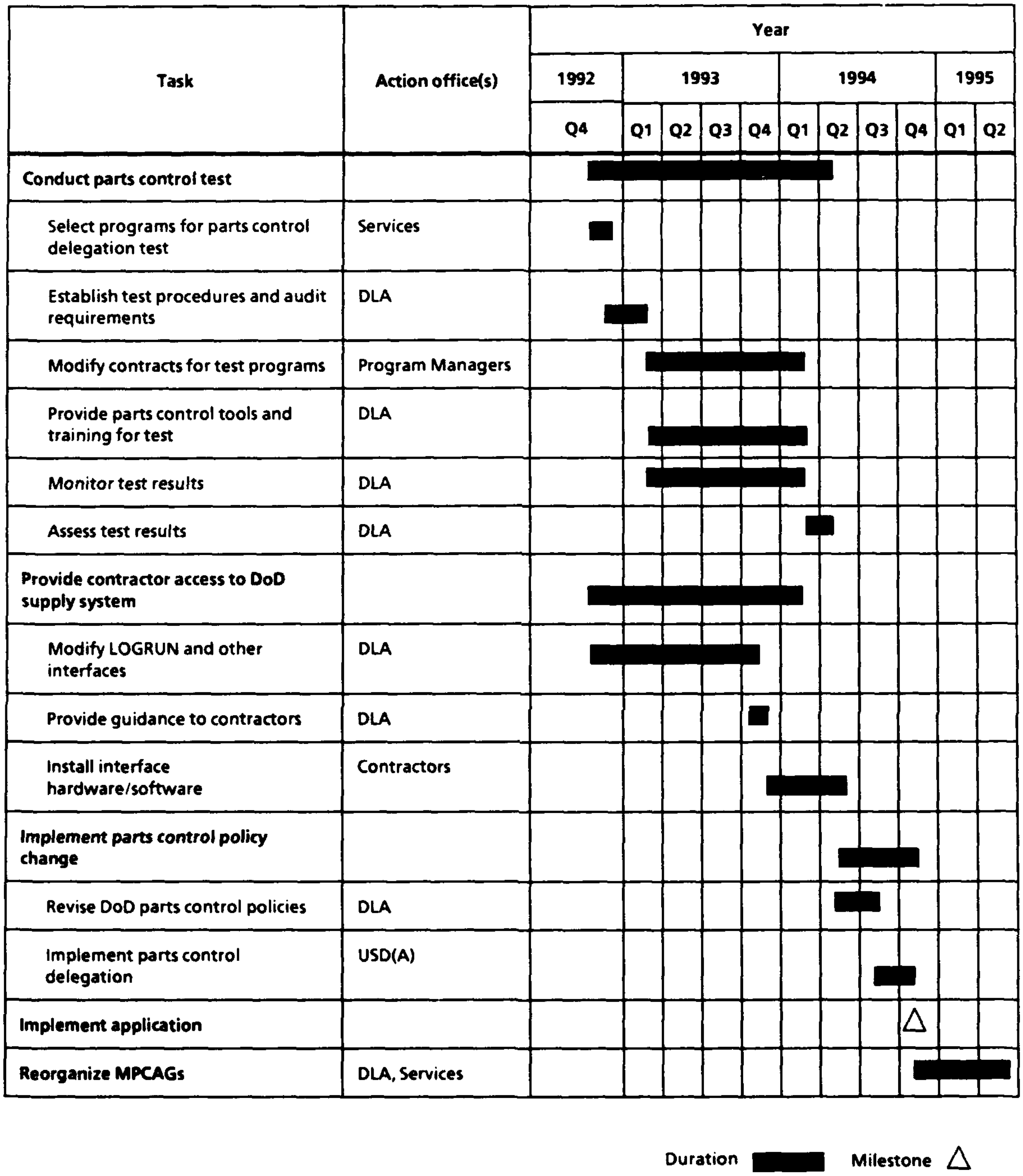


FIG. 4-2. CONTRACTOR ACCESS TO DoD SUPPLY SYSTEM DATA

proposed change (e.g., other components or subsystems, spare parts, maintenance procedures, training courses, support/training equipment, technical manuals, etc.). Rapid processing and implementation of ECPs is essential for maintaining schedules and minimizing costs. Delays can affect schedules for procuring materials, implementing production process changes, preparing new provisioning parts lists, coordinating changes to affected components or subsystems with other contractors, and revising drawings and technical manuals. Since most ECPs are generated during the production phase, delays generally result in the continued production of hardware without the change, and thus, more delivered equipment than originally intended must be modified. Delays increase the cost of the ECP and require the equipment to be removed from service to incorporate the change.

Government processing time for ECPs is excessive. In accordance with MIL-STD-973, *Configuration Management,* 17 April 1992, the Government should review, evaluate, order, and implement a routine ECP within 90 calendar days. Current processing time ranges from 3 months to more than a year from the time a contractor submits the ECP until the configuration control board (CCB) completes its action. An additional undetermined time is required to authorize and implement the ECP.

Factors contributing to the excessive processing time include numerous personnel involved in the process, geographic separation of review personnel, time required to handle the ECP at each location, and time required to resolve discrepancies and revise the ECP.

Traditionally, an ECP is submitted to the Government in hard copy on a Defense Department (DD) Form 1692, *Engineering Change Proposal.* It is received, recorded, duplicated, and mailed to the affected technical disciplines for concurrent review. Upon receipt at the secondary sites, the ECP is handled in a similar manner again, reviewed, and returned by mail with comments. Upon return to the original site, the ECP is handled a third time and routed for review by program personnel. If discrepancies or omissions occur in the ECP, it is returned to the contractor, a revised ECP is submitted, and the entire process must be repeated. CALS can accelerate this process through electronic submission, review, and approval of the ECP.

Each Service, and each component organization within the Services, processes ECPs differently; some have centralized control and approval by a formally convened

CCB, while in others control is decentralized and the program manager is the approval authority. Statistical information related to quantity of ECPs, quality and completeness of the ECP, preparation and processing times, and implementation management is generally available only at the program or project level except for a few commands that maintain central control. However, even in those commands, some end items are outside the central control system. For all practical purposes, statistical information for ECPs is not easily obtained.

Once approved, ECP implementation requires the coordination of schedules of all affected areas to ensure they converge at the point at which the ECP becomes effective. Incorporating a major design change in new production hardware prior to modifying training, test, or support equipment; updating technical manuals and maintenance procedures; or provisioning spare parts would degrade the effect of the change and could result in additional cost. Currently, the implementation of an ECP is generally tracked manually if at all and usually consists of checking the status if a milestone is missed. The Naval Air Systems Command's (NAVAIR's) Modification Management Information System (MODMIS) is an automated system that contains these milestones in a central data base that can be accessed by Government personnel and by the contractor submitting the ECP. However, the information cannot be updated on a real-time basis by the organization responsible for taking action, nor can other contractors access these data. CALS can help improve ECP implementation by providing for real-time inputs of implementation information by the responsible organization.

The importance of CM in the acquisition process is recognized by its inclusion in DoDI 5000.2. Establishing and maintaining configuration control is an essential element of a successful acquisition program. Accelerating the process by which changes to weapon systems are effected will result in improved system performance earlier and in reducing the costs associated with design changes. CALS applications can greatly help in this process.

Several studies and reports identify benefits that can be achieved by applying CALS initiatives. Despite the general agreement that CALS benefits are significant, these benefits are difficult to measure using traditional cost/benefit methodologies. Those methodologies that attempt to identify savings estimate those savings in terms of a percentage reduction in the time to perform a task, in the quantity of items processed, in labor hours, or in cost. However, none quantifies the base to which the percentage reduction should be applied. For example, the *CALS/Concurrent Engineering Benefits Working Group Report* of September 1989, estimates a 30 percent to 50 percent reduction in the time needed to process an ECP but does not specify the average ECP processing time. The *EDI Planning and Implementation Guide*[5] comes the closest to quantifying savings by identifying common processing operations associated with frequently used DoD documents and applying savings figures on the basis of the engineered work standards developed by the Defense Finance and Accounting Service. The recommendations presented for Application 3 incorporate the percentage reductions identified in previous studies of CALS applications for similar tasks and, where available, the savings based on engineered work standards in an attempt to quantify the savings.

The recommended CALS applications for ECPs may be divided into ECP submission and processing and ECP implementation.

Application 3: ECP Submission and Processing

Recommendations. We offer the following five recommendations with regard to ECP submission and processing:

- *Direct that contractors submit ECPs and supporting technical documentation to DoD in CALS-compliant format.* Contractors typically prepare and submit ECPs in hard copy on DD Form 1692 to the program manager for further distribution. Following our recommendation would accelerate the submission of the ECP to the Government and its distribution to technical disciplines for review.

- *Support the designation and use of a system such as the Army's Multi-User Engineering Change Proposal Automated Review System (MEARS)*[6] *for electronic receipt, storage, distribution, and review of ECPs as the DoD standard system.* Currently, ECPs are submitted, received, duplicated, distributed, reviewed, and stored in hard-copy form. MEARS is designed to

[5]Logistics Management Institute (LMI) Report DL203RD1, *EDI Planning and Implementation Guide,* Thomas P. Hardcastle, August 1992.

[6]We did not conduct an exhaustive search for, or comparison of, systems throughout DoD with similar functionality to MEARS, MODMIS, and the Configuration and Logistics Information Program (CLIP). We, therefore, do not specifically recommend any of these systems as the final solution. What we do suggest is that these systems in total represent the functionality required of an integrated ECP/configuration management system. MODMIS and CLIP have already been designated as DoD standard systems, and MEARS is nearing IOC. We recommend that the capability represented by these systems be made available throughout DoD either by integrating these or other existing systems, by incorporating these systems under JCALS, or by following some other specific course of action.

receive contractor-prepared ECPs in digital form and drawings in raster images either on floppy disk or direct transmission from a personal computer (PC) to a central data base. The ECP can then be accessed by the affected technical disciplines for on-line review, comment, and approval.

- *Provide for direct input of ECP technical documentation from MEARS to JEDMICS.* JEDMICS is the DoD's standard digital data storage and processing system. After drawings associated with an ECP are adequately reviewed and accepted, direct input from MEARS will accelerate the availability of technical data to all users.

- *Require the use of MODMIS, DoD's standard system for ECP process management.* Centralized electronic control and tracking of ECPs could significantly reduce ECP processing time, provide real-time visibility of ECP status for Government and contractor personnel, identify areas for further process improvement, and gather valuable statistics not currently available. While MEARS provides the capability for electronic distribution of the ECP and drawings, MODMIS provides the capability for managing the ECP review process including tracking the ECP, preparing internal documentation, tracking ECP implementation, and maintaining configuration status accounting. MODMIS should be modified to provide for real-time inputs of implementation information by the responsible organizations.

- *Support integrating portions of MODMIS and MEARS within the CLIP to enhance CLIP's configuration status accounting and configuration audit features.* Configuration status accounting starts with the establishment of a product baseline. Each approved ECP changes that baseline and must be tracked to maintain configuration management of the item. Configuration audits, which verify that items are in compliance with their approved configuration baseline, can be conducted easier when all information resides in a single data base. Incorporating portions of MEARS and MODMIS within CLIP would accelerate the availability of a complete configuration management system for all DoD items.

Prerequisites. To ensure effective ECP submission and processing, the following prerequisites are necessary:

- *DoD must implement MEARS.* MEARS is an Army system that provides the capability to directly transmit ECPs and technical drawings in digital form for Government review. It is currently scheduled to be implemented on the Patriot Missile System in the spring of 1993. Widespread implementation of MEARS or a similar capability is required to accommodate the electronic receipt, review, and approval of ECPs.

- *DoD must implement MODMIS.* MODMIS is the designated DoD standard system for management and tracking of system changes. It is currently used only by NAVAIR for aviation equipment. Its widespread implementation is required to track the ECP through the review and approval process and to ensure rapid implementation of approved ECPs.

- *DoD must implement JEDMICS.* JEDMICS is the designated DoD standard digital data storage and processing system. Its widespread installation is required to provide storage and accessibility of digital technical data.

- *DoD must implement CLIP.* CLIP is the standard DoD system for configuration management. It is currently installed at some Army, Navy, Air Force, and Marine Corps facilities and is scheduled for implementation at a DLA site in the near term. Its widespread implementation is required in order to accept inputs from MEARS and MODMIS and to provide configuration and logistics information for all DoD weapon systems.

Schedule Impacts. The use of CALS for submission and processing of ECPs can have the following effects on schedules:

- The elapsed time for ECP submission, duplication, and distribution can be reduced by an estimated 25 percent to 50 percent.

- The elapsed ECP review time can be reduced by an estimated 30 percent to 50 percent.

- The elapsed time for ECP revision can be reduced by an estimated 25 percent.

- The elapsed time for preparation of CCB documentation can be reduced by an estimated 30 percent.

Savings Impacts. The application of CALS in the submission and processing of ECPs can bring about the following savings:

- An estimated $116 million annually can be saved DoD-wide in the receipt, duplication, distribution, data entry, review, document preparation, tracking, and filing of ECPs (see Figure 4-1).

- An ECP can be implemented earlier in the production run, thereby saving the cost of manufacturing and installing additional retrofit kits.

- Storage space for ECPs and associated documentation and reports can be reduced and eventually eliminated.

Investment Requirements. Investments would be needed in the following areas to apply CALS to the submission and processing of ECPs:

- To procure, install, and maintain LANs to review ECPs and technical drawings entered in MEARS.

- To train users on a LAN.
- To develop, install, and test modifications to MEARS and MODMIS.
- To develop, install, and test interfaces between MEARS, MODMIS, JEDMICS, and CLIP.
- To develop the telecommunications needed to transmit and access data.

Policy/Regulatory Implications. Applying CALS to the submission and processing of ECPs would require revisions to the following documents:

- MIL-STD-973, *Configuration Management*, paragraph 4.3, to require that contracts specify that contractors will provide configuration documentation in CALS-compliant digital form.
- MIL-STD-973, paragraph 4.3.2, to require that contracts specify the contractor will use automated processing and electronic submittal techniques.
- DoDD 5000.1, *Defense Acquisition*, part 1, paragraph c.2., to stipulate that ECPs will be processed using DoD CALS-compliant standard systems.
- DoDI 5000.2, part 9-A, to require Acquisition Category (ACAT) I, II, III, and IV programs to establish configuration control for the program using DoD CALS-compliant standard systems.

Proposed Implementation Plan. In implementing this CALS application, DoD should continue to field MEARS and to export MODMIS and CLIP to all DoD Components. It should conduct system interface meetings among the MEARS, MODMIS, CLIP, JEDMICS, and JCALS programs and develop appropriate interfaces. In addition, OSD should issue MIL-STD changes and other guidance to require digital ECP submission from contractors. Implementation of this application is estimated in mid-1994 (see Figure 4-3).

Application 4: ECP Implementation

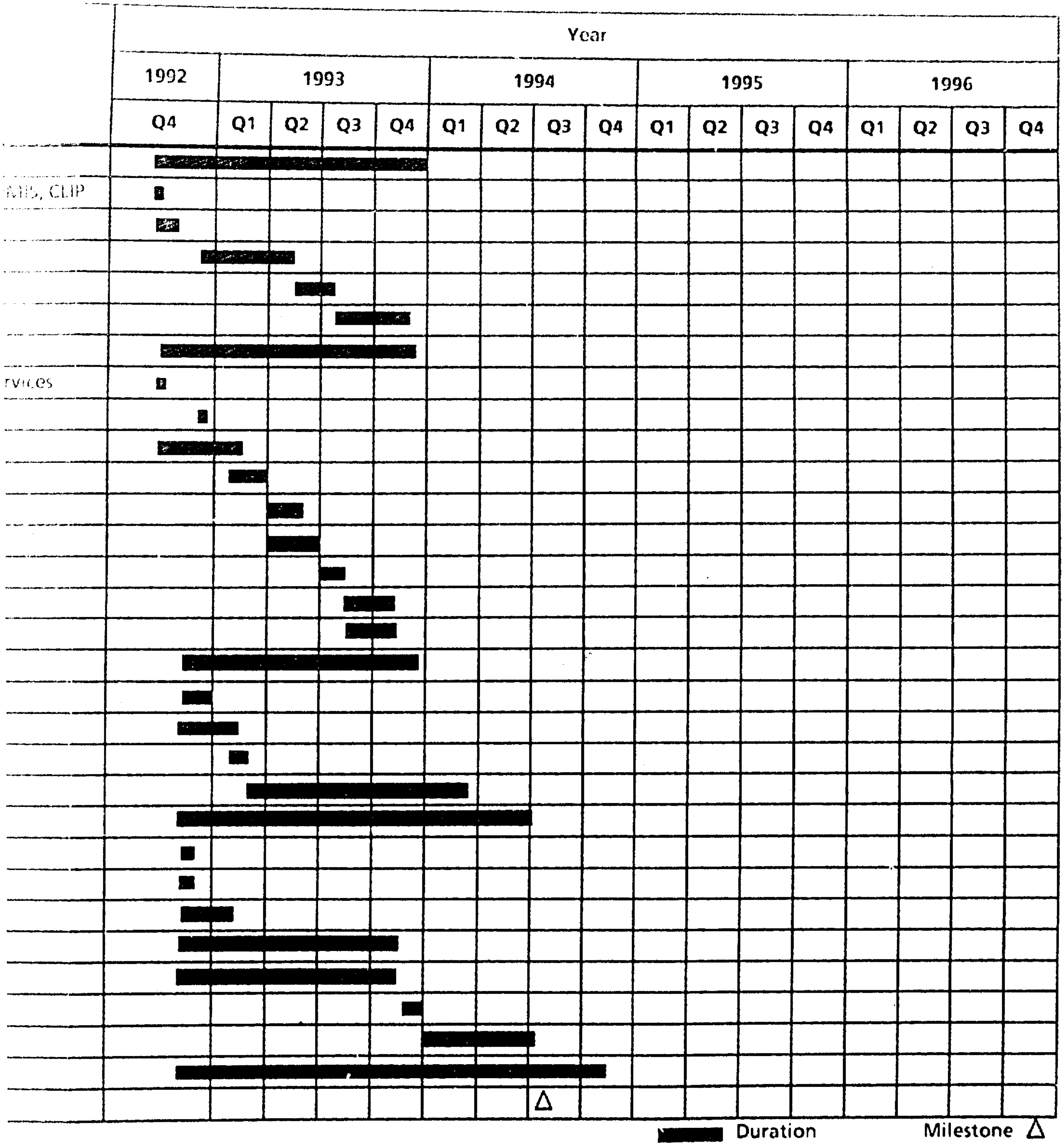
Recommendations. We offer the following three recommendations to facilitate ECP implementation:

- *The MODMIS Executive Agent should be requested to modify MODMIS to coordinate activities of contractors and Government facilities involved in ECP implementation.* ECP implementation requires that a variety of actions be tracked and controlled to maintain the schedule of the ECP and to ensure that effective support for the modified hardware is provided. Centralized automated control over the ECP implementation process will help ensure

Task	Action office(s)	1992
		Q4
MEARS/MODMIS/CLIP integration		
Conduct exploratory meeting	DoD CALS, JCALS, JLSC, MEARS, MODMIS, CLIP	
Identify/document system interface requirements	JCALS, MEARS, MODMIS, CLIP	
Develop system interfaces	JCALS, MEARS, MODMIS, CLIP	
Install and test system interfaces	JCALS, MEARS, MODMIS, CLIP	
Implement interfaces	Services	
Implement MEARS and MODMIS		
Establish tri-Service review group	DoD CALS, JLSC, MEARS, MODMIS, Services	
Review current MEARS/MODMIS capabilities	Tri-Service review group	
Identify unique Service requirements	Tri-Service review group	
Identify necessary system modifications	MEARS, MODMIS	
Develop MEARS on-line training package	MEARS, MODMIS	
Modify systems	MEARS, MODMIS	
Install and test system modifications	MEARS, MODMIS	
Implement MEARS/MODMIS	Services	
Train MEARS/MODMIS users	Services	
JEDMICS/MEARS interface		
Identify/document system interface requirements	JEDMICS, MEARS	
Develop system interfaces	JEDMICS, MEARS	
Install and test system interfaces	JEDMICS, MEARS	
Implement interface	JEDMICS, MEARS	
Direct contractor digital ECP submission		
Establish functional requirements	DoD CALS	
Determine DoD telecommunications requirements	DISA	
Identify DoD computer hardware/software requirements	PMs	
Procure and install equipment and software	PMs	
Prepare regulation changes	DDR&E	
Issue guidance	DDR&E	
Require contractor digital ECP submission	PMs	
Implement JEDMICS	JEDMICS	
Implement application		

Note: We did not conduct an exhaustive search for, or comparison of, systems throughout DoD with similar functionality to MEARS, MODMIS, and the Cc· fig the final solution. What we do suggest is that these systems in total represent the functionality required of an integrated ECP/configuration management system that the capability represented by these systems be made available throughout DoD either by integrating these or other existing systems, by incorporating these sys

FIG. 4-3. ECP SUBMISSION AND PROCE



ERS, MODMIS, and the Configuration and Logistics Information Program (CLIP). We, therefore, do not specifically recommend any of these systems as uration management system. MODMIS and CLIP have already been designated as DoD standard systems, and MEARS is nearing IOC. We recommend ms, by incorporating these systems under JCALS, or by following some other specific course of action.

BMISSION AND PROCESSING

the "just-in-time" arrival of all production and support elements for the proposed change. As currently designed, MODMIS tracks one-time event milestones (e.g., ordering technical manuals, design change notice/provisioning data submitted) that are input by NAVAIR based on information contained in the ECP. The milestone dates can be revised if slippages occur, but the information must flow manually from the responsible organization to NAVAIR. Tracking ECP implementation could be enhanced if this information was input directly by either the Government activity or the contractor who performs the function being tracked.

- *Contractors and Government facilities* should *provide MODMIS with real-time inputs that have an impact on ECP implementation.* Initial implementation milestones for engineering efforts, production schedules, Government-furnished equipment (GFE) deliveries, technical manual (TM) updates, modification kit deliveries, installation schedules, etc., should all be updated on a real-time basis with comments on their current status, anticipated problems, and "get-well" schedules. These inputs should be entered into MODMIS directly by the responsible organization.
- *All contractors and Government facilities should be given direct access to MODMIS implementation status.* Real-time information will enable all impacted contractors and Government facilities to adjust their internal schedules to accommodate unforeseen problems in implementing an ECP. Direct access to this information by the Government and contractors will permit a more rapid response to changing conditions.

Prerequisites. To ensure effective ECP implementation, DoD must implement MODMIS. MODMIS is the designated DoD standard system for managing and tracking system changes. Although it is currently used only by NAVAIR for aviation equipment, its widespread implementation is required to track the ECP through the review and approval process and to ensure rapid implementation of approved ECPs.

Schedule Impacts. The use of CALS in ECP implementation will have the following effects on schedules:

- It will result in more timely implementation of approved ECPs.
- It will offer more timely support for modified weapon systems.
- It will ensure earlier change to production configurations, resulting in fewer installations of modification kits and less "out-of-service" time for systems to be retrofitted.

Savings Impacts. The application of CALS in the implementation of ECPs will bring about the following cost savings:

- Production costs will be reduced because of the increased ability of the contractor to schedule production-line modifications to accommodate incorporation of hardware changes.
- Potential savings will accrue from more timely identification of new spare parts, thus reducing the procurement quantity of replenishment spares that will not be used in the new hardware configuration.

Investment Requirements. The investment costs for this application of CALS are as follows:

- The cost to develop, install, and test the modifications to MODMIS
- The costs of the telecommunications system needed to transmit and access data.

Policy/Regulatory Implications. No policies or regulations are impacted by this recommendation. Program managers are responsible for implementing ECPs, and how they fulfill that responsibility is their decision. MODMIS, however, is a tool that can greatly assist them with this vital function.

Proposed Implementation Plan. A six-step plan and schedule for the modification of MODMIS to facilitate ECP implementation is presented in Figure 4-4.

ECP Savings Computation

We computed savings on ECP processing (see Table 4-1) and retrofitting and combine them to show total DoD-wide savings.

ECP Processing Savings. The following savings are based on estimates prepared for the *EDI Planning and Implementation Guide.*[7] Savings figures were adjusted for the number of times an ECP is handled and for the relatively greater complexity represented by ECPs compared to the simpler procurement forms measured for the *EDI Guide*.

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[7]LMI Report DL203RD1. Op. cit.

Task	Action office(s)	1992	1993			
		Q4	Q1	Q2	Q3	Q4
Modify MODMIS						
Conduct meeting with MODMIS PM	DoD CALS, MODMIS					
Identify required MODMIS modifications	MODMIS					
Revise MODMIS on-line training module	MODMIS					
Develop system modifications	MODMIS					
Install and test modifications	MODMIS					
Provide for direct contractor access to MODMIS	MODMIS					
Implement application						△

Duration ▬ Milestone △

Note: We did not conduct an exhaustive search for, or comparison of, systems throughout DoD with similar functionality to MEARS, MODMIS, and the Configuration and Logistics Information Program (CLIP). We, therefore, do not specifically recommend any of these systems as the final solution. What we do suggest is that these systems in total represent the functionality required of an integrated ECP/configuration management system. MODMIS and CLIP have already been designated as DoD standard systems, and MEARS is nearing IOC. We recommend that the capability represented by these systems be made available throughout DoD either by integrating these or other existing systems, by incorporating these systems under JCALS, or by following some other specific course of action.

FIG. 4-4. ECP IMPLEMENTATION

Approximately 100,000 ECPs are processed annually, which represents a potential DoD-wide ECP processing savings of about $116 million a year (100,000 ECPs per year x $1,159.60 savings per ECP = $115.96 million).

Retrofit Savings. Assuming that 1,000 retrofit kits a year are no longer required because production changes occur sooner and assuming that the average cost per kit is $10,000, the total DoD-wide savings from fewer retrofits is $10 million a year.

TABLE 4-1

ECP PROCESSING SAVINGS PER DOCUMENT

Task	Savings per document ($)[a]	Times handled	Complexity[b]	Total savings per ECP ($)
Document Distribution	0.06	20	5	6.00
Mailing	0.52	20	1	10.40
Document receipt	0.16	20	1	3.20
Document review	1.82	40	10	728.00
Document preparation and control	2.25	10	10	225.00
Data entry	1.19	20	5	119.00
Data storage and retrieval	0.68	20	5	68.00
Total				1,159.60

[a]Represents savings per document per time handled. We selected the highest savings figure calculated for each task among the procurement documents studied for the *EDI Guide*.

[b]Complexity represents the number of times more complex each task is for ECP processing compared to that for the procurement documents reviewed for the *EDI Guide*. A one indicates equal complexity, a five indicates a five-times-greater complexity for ECP processing versus procurement processing, etc.

Total ECP Savings Per Year. Combining the processing savings and the retrofit savings gives DoD-wide savings of $126 million per year.

Technical Data Packages

Introduction

A TDP consists of definitive reference technical information about the design of a weapon system, and it supports weapon system development, production, and operation. TDPs include physical descriptions (e.g., dimensions, type of materials) and manufacturing process information. Many acquisition and logistics activities are either directly or indirectly dependent on TDPs as source data. Examples of these activities include logistics support analyses, provisioning, technical manuals, spare parts procurement, development of support equipment, interfaces to other systems, and training.

Historically, TDPs have been submitted to DoD in hard copy or on aperture cards even when they were produced on computer-aided design/computer-aided manufacturing (CAD/CAM) equipment in digital form. Hard-copy TDPs are bulky and difficult to update, store, and distribute. Each drawing received by an automated repository must be electronically "indexed" to identify its location in the system and other relevant information (e.g., drawing number, type of drawing, and rights-in-data limitations). Some repositories also index relationships among drawings so they can automatically retrieve all drawings for a particular NSN item (i.e., a bid set). Significant resources are required at each technical data repository to index each drawing. Repetitive manual indexing can lead to indexing errors that result in inability to find the drawing later, or in generation of erroneous bid set packages.

Failure to disseminate complete and accurate technical data to all activities needing it can lead to wasted or counterproductive effort by acquisition and logistics support personnel. For example, if the design for the receptacle for a plug-in test unit is originally a bayonet-type plug (i.e., insert and twist), procedures in the TM will be written to insert and twist the plug. If the design is changed to a pin-type plug (i.e., align pins and insert) but the design change is slow in being disseminated, the TM will still instruct users to insert and twist the plug. Following the manual will lead to broken plugs and degraded operations. If the design change could be disseminated sooner, the original TM might be able to reflect the change without the need for a separate revision. So doing would save the cost of the TM change, the potential cost of damage to equipment, and unnecessary equipment downtime. If a TM change is still required, it could be made and disseminated quickly.

Our recommended CALS applications for TDPs fall into three areas: TDP delivery and acceptance, TDP distribution, and DoD data repository consolidation.

Application 5: TDP Delivery and Acceptance

Recommendations. We make the following three recommendations for TDP delivery and acceptance:

- *When DoD orders TDPs, it should require digital delivery of existing technical data as well as new and revised drawings.* Technical data managers typically acquire only new and revised technical data on the assumption that data for existing items are already in Government repositories. Implementing this recommendation would assure that digital versions of all technical data for current weapon systems are acquired on contract and made available through JEDMICS. This recommendation would be followed until a sizable majority of data in DoD repositories are in CALS-compliant, digital format; at that point, only new and revised data would be delivered.

- *DoD should require that electronic indexing data be submitted with TDPs (including an NSN-to-part-number cross-reference).* Digital indexing data would include drawing numbers, associated NSNs, rights in data, distribution restrictions, and other information required for each drawing or associated document in the TDP.

- *DoD should increase automation of TDP reviews.* Digital TDPs should permit more automated review for format and content errors. Standard error-detection features of CAD/CAM systems should be recognized by Government TDP reviewers and not be double-checked during review of CAD/CAM output.

Prerequisites. Before TDP delivery and acceptance can be made more effective, the following prerequisites must be met:

- *DoD must implement JEDMICS.* JEDMICS is DoD's standard digital engineering data storage and processing system. Its widespread installation is required (in the near term) to provide a place for digital TDPs delivered by contractors to be stored and accessed.

- *DoD must identify standard indexing data.* Consensus among DoD technical data managers is needed for a mandatory standardized set of indexing data to be provided by contractors with TDPs.

- *Data must be converted to raster and vector digital formats in a cost-effective manner.* Even on new weapon systems, a significant amount of non-CALS technical data is used in the weapon system design process. Additionally, most of the technical data already stored in DoD repositories are not in CALS formats. A significant amount of DoD's technical data must be accessible in digital, CALS-compliant form before digital TDPs can pay off. As an example of the problems encountered prior to reaching that amount, consider a four-drawing bid set in which one drawing is updated and delivered digitally. Having three drawings on aperture cards and one on an electronic file will likely cause more operational problems for procurement than either an all aperture card or all digital medium. A conversion program that permits the systematic conversion of all active technical data on an economical basis would help DoD reach the necessary amount much sooner and less painfully than would an incremental approach of merely accepting new and revised drawings in digital format.

- *Industry must modernize.* Industry needs to make the investment necessary to handle digital data that is to be delivered to and received from the Government (e.g., for spares procurement).

Schedule Impacts. The use of CALS for delivery and acceptance of TDPs will have the following impacts on schedules:

- *Faster TDP review and approval will be possible.* Recording TDPs digitally increases the ability to use computers to edit and validate them. Some checks can be performed by CAD/CAM systems on input. These conditions would not need to be rechecked during Government review and acceptance. Other content and format checks could be performed automatically by DoD when the TDP is submitted. This would decrease the personal effort needed to review TDPs and probably improve the quality of the review by eliminating the need to review many tedious details manually.

- *Organic support of the weapon system will be available sooner.* Faster review and acceptance of the TDP and faster indexing of the TDP into DoD repositories would make the TDP available to supporting activities sooner for use in spares acquisition and other supply support functions.

- *Fewer delays will occur in reflecting design changes in technical manuals, training, and provisioning.* Many support activities (e.g., TM preparation, provisioning, and training) use the TDP as a reference. By making TDP updates available to these communities sooner, document updates can be made quicker and design changes can be fielded earlier.

Savings Impacts. The application of CALS in the delivery and acceptance of TDPs will have the following savings impacts:

- *It will reduce the cost of converting legacy data.* If the same data are available in several repositories (which is likely), then each repository may eventually digitize the same drawing. By temporarily requiring submittal of existing drawings in digital format, a drawing would only need to be digitized once by the contractor, then shared with all other repositories in digital form, eliminating the need for each repository to digitize the drawing.

- *Less time will be lost by support functions in preparing to support obsolete designs.* Better visibility of pending and approved design changes will allow support functions to suspend effort in areas in which the design changes will result in rework. The work effort saved can be used to reduce cycle time or to reduce personnel strengths.

- *The indexing workload will be reduced.* Repositories spend a significant amount of time indexing the drawings they acquire. By having contractors deliver indexing data digitally, repositories would only have to add the drawing location information specific to that repository. DoD-wide savings are estimated to be $4 million.

- *The TDP review costs will be reduced.* Faster TDP review will reduce workload.

- *Legacy data will be converted systematically.* During the transition period, all related data would be submitted digitally, increasing the chances that if any part of a bid set or TDP were digital, the entire package would be digital. That situation would speed filling TDP requests by avoiding the need to scan aperture cards prior to filling the request.

- *Fewer missing or illegible drawings will exist.* Greater availability of legible data will decrease acquisition lead time and increase the potential for competitive spares procurements. That will, in turn, reduce DoD inventory investment and contract prices. By delivering existing as well as new drawings for a time, "missing" existing drawings can be replaced in the DoD repository system. The digital drawings will also help improve legibility of drawings in DoD repositories since digital files do not lose legibility when copied for distribution to another repository the way aperture cards do when reproduced for distribution. Digital TDPs will retain their legibility regardless of the number of times they are copied.

Investment Requirements. The following investment is needed to apply CALS to the delivery and acceptance of TDPs:

- *Legacy data conversion.* Additional cost would be incurred by program managers to acquire existing data in digital form along with new and revised data. The cost of acquiring such data will be limited, however, to the cost of scanning and delivery.

- *Acquisition of TDP review software.* Software will need to be developed or acquired to automate portions of the TDP review.

- *JEDMICS software change to accept digital indexing data.* With a software change, JEDMICS will be able to automatically assemble bid sets based on NSN. JEDMICS indexing is based only on the drawing number at the present time.

Policy/Regulatory Implications. Application of CALS to the delivery and acceptance of TDPs would affect Military Specification MIL-T-31000, *Technical Data Packages, General Specification for,* in two places:

- Paragraph 3.7 would have to be changed to require delivery of TDP management data products in digital form.

- Appendix A, Paragraph 40.2.1.3 would have to be changed to *require* rather than *prefer* digital data delivery.

Temporarily, DoD would also have to change the technical data management practice from buying new and revised drawings only to buying existing drawings as well, when the existing drawings are not already available to DoD in digital format. The cost of acquiring these drawings should not exceed the digitization and delivery cost.

Proposed Implementation Plan. The DoD must review its data conversion policy in support of JEDMICS implementation and issue any new guidance required. It must also establish a method for exchanging engineering drawing indexing data, require digital submittal of TDPs, include existing data held by DoD in legacy forms, and increase automation of TDP review and acceptance. Implementation is estimated in late 1994. The number of personnel assigned to TDP review can be reduced following implementation (see Figure 4-5,

Application 6: TDP Distribution

Recommendation. *Contractors should deliver accepted TDPs and updates directly to the primary Service repository and to all supporting inventory control point (ICP) repositories.* Today, they generally deliver to a primary Service repository. Other activities that require data contained in the TDP must request each individual drawing or other document. That procedure is costly and time consuming. Our recommendation would ensure that TDPs (or the applicable portions of them) are "pushed" to ICPs and other activities supporting the weapon system rather than making ICPs and other activities "pull" the data they require. This recommendation is required until CITIS and telecommunications capabilities permit better access to source data bases and greater consolidation of data repositories.

Prerequisites. *The improved TDP distribution is dependent on JEDMICS implementation.* JEDMICS is the DoD's standard digital engineering data storage and processing system. Its widespread installation is required (in the near term) to provide a place for storing and accessing digital TDPs delivered by contractors.

Schedule Impacts. *Improved TDP distribution will permit faster organic supply support for the weapon system.* Providing the relevant portions of the TDP before

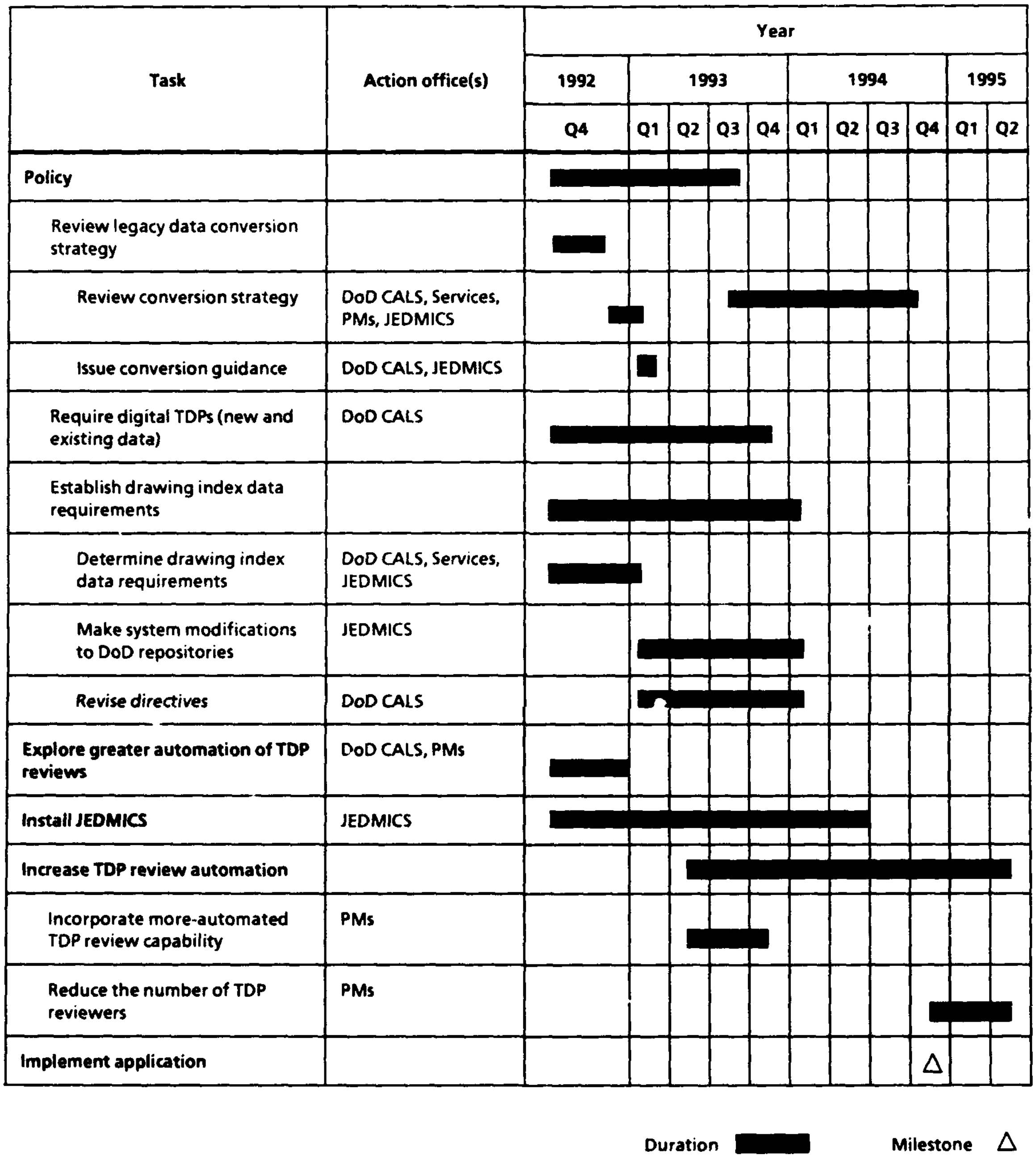


FIG. 4-5. TECHNICAL DATA PACKAGE DELIVERY AND ACCEPTANCE

they are needed and faster indexing of the TDP into DoD repositories will make the TDP available sooner for use in spares acquisition.

Savings Impacts. Improved TDP distribution will affect savings as follows:

- *It will reduce administrative lead time (ALT) and improve weapon system support.* If more and higher quality data are available sooner, ICPs will be able to spend less time searching for technical data from external sources to support technical reviews and procurements.

- *Competitive spares procurement will be increased.* For those items with unlimited DoD rights in data, increased availability of TDPs is a key factor in greater competitive procurement and lower weapon system support costs.

- *The cost of converting legacy data will be reduced.* DoD repositories can avoid the cost of digitizing legacy data that is distributed as part of a weapon system deliverable. The legibility of the data will probably also be much improved over that of the aperture card version.

- *The cost of acquiring data from the primary repository will be reduced.* Today, if a secondary DoD repository (e.g., a DLA hardware center) cannot fill requests for technical data internally, the repository will go to the primary DoD repository (i.e., the Service repository to which the original weapon system TDP was delivered) to acquire the data. If the primary repository does not have the data or the data are illegible, the secondary repository will ask the drawing originator (i.e., the contractor or Government design activity) for the drawing. This process takes considerable time. By automatically pushing approved TDPs to supporting repositories, the data acquisition workload at the secondary repositories can be significantly reduced.

- *It will improve the legibility of data.* Even if data are available at a repository, the legibility of those data may be marginal if the "master" aperture card in the repository is a second- or third-generation copy of the original. Since redistributing digital files causes no loss of legibility, distributing existing drawings in digital format from contractors will allow repositories to replace marginally readable data with data files as legible as the original. Previously illegible data will then be available for technical reviews and for use in competitive procurement in those cases where the Government has unlimited rights to the data.

Investment Requirements. The primary investment will be for breakout of TDPs by repository. Unless repositories choose to store complete TDPs for every weapon system they support, some workload will be incurred in identifying the relevant portions of a weapon system TDP to be stored at each repository. This work could fall on the contractor to tailor TDPs to each repository's needs or on the repository to receive the entire TDP and choose what to store on its own.

Policy/Regulatory Implications. Insofar as policy is concerned, technical data management guidance will have to be revised to require accepted TDPs and updates for each weapon system to be automatically distributed to each of the weapon system's logistics support activities.

Proposed Implementation Plan. The steps in the proposed implementation plan are shown in Figure 4-6. They consist of determining the best way to tailor TDPs for supporting activities, installing JEDMICS, issuing guidance to begin automatic distribution of TDPs, and reducing personnel assigned to internal DoD data acquisition and indexing after implementation of the recommendation. Implementation is estimated in late 1994.

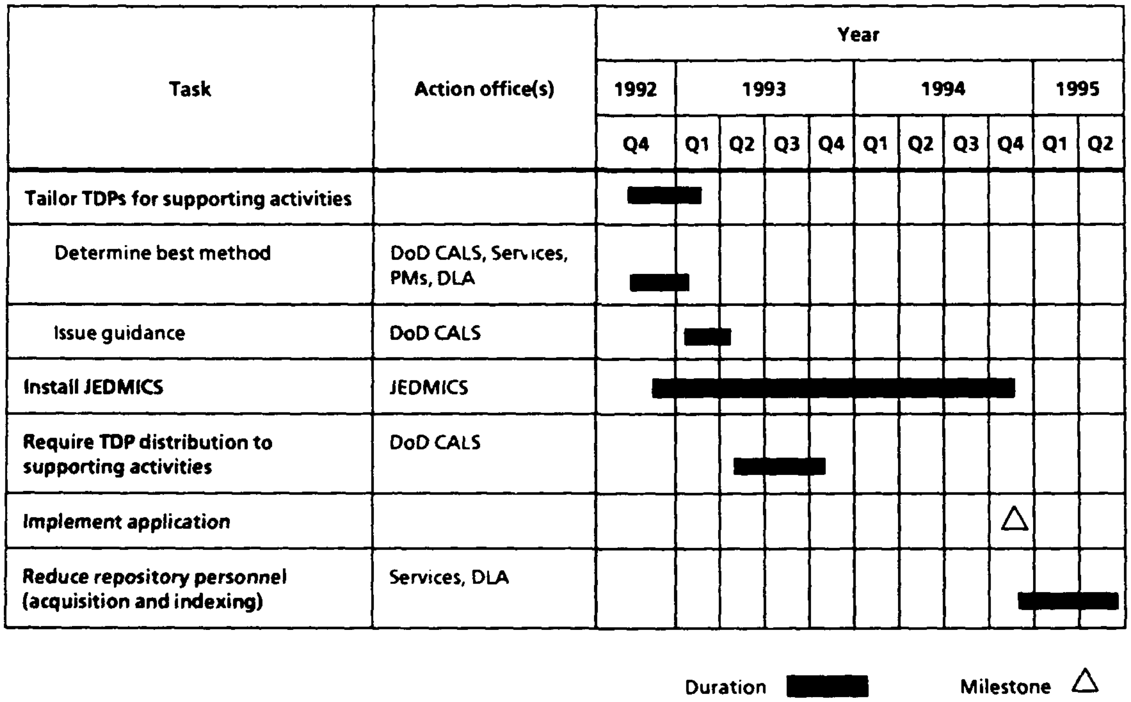


FIG. 4-6. TECHNICAL DATA PACKAGE DISTRIBUTION

Application 7: DoD Data Repository Consolidation

Recommendations. *DoD should consolidate its data repositories as the CITIS environment develops (i.e., where the TDP is widely accessible through the prime contractor's CITIS data base) and once telecommunications capacity permits feasible high-volume electronic transmittal of engineering data.* Engineering drawings require more telecommunications capacity than is generally available today, leading to an unacceptably long transmission time per drawing. While some small, emergency drawing requests can be met through telecommunications, the bulk of TDP transmittal will be by optical disk or magnetic tape in the near and perhaps mid term. As data compression and telecommunication bandwidth increase, however, DoD needs to be prepared to consolidate repositories and to provide on-demand technical data to authorized users.

Prerequisites. The following conditions are prerequisites to the consolidation of DoD data repositories:

- *CITIS must be implemented.* CITIS provides the standard query environment necessary for accessing information in an integrated (but distributed) weapon system data base. Until this service is available, TDPs will need to be physically delivered to DoD repositories in digital format.

- *Adequate telecommunications capacity must be available.* Graphics files tend to be much larger than text files, consuming more file space and placing more demands on telecommunications systems for electronic transfer. Data compression technology tends to reduce the size of graphics files during storage and transmission, but the challenge is still great. At present, limited bandwidth capacity in much of the telecommunications network limits the rate at which data can be transmitted, resulting in unacceptably long transmission times for graphics (especially those as sophisticated as engineering drawings). The installed national telecommunications network capacity must be upgraded sufficiently to permit timely transmittal of complex engineering data before our recommendation can be fully implemented. Until then, delivery of digital TDPs by optical disk or magnetic tape to DoD repositories will likely be the preferred delivery method.

- *JEDMICS must be implemented.* JEDMICS is DoD's standard digital engineering data storage and processing system. Its widespread installation is required (in the near term) to provide storage of and access to digital TDPs delivered by contractors.

- *DoD suppliers must have the capability to process digital (CALS) data.* Today, much of the workload of DoD repositories is dedicated to reproducing aperture card bid sets for procurement. DoD repository consolidation will probably not be feasible until most DoD bidders and suppliers can process digital bid sets.

Schedule Impacts. Consolidation of DoD data repositories will have the following effects on the acquisition process:

- *Faster TDP review and approval will be possible.* The consolidation will eliminate the time required to distribute TDPs.
- *Organic support of the weapon system can begin sooner.* The ALT for spares procurements will be reduced by eliminating most intermediate processing of TDPs and bid sets in support of parts procurement.
- *Fewer delays will be caused by reliance on obsolete design.* Anyone needing the current configuration can access the authoritative TDP data base, reducing the probability that effort will be expended supporting a superseded design. The work force will then be more available to address support of the current design.

Savings Impacts. Consolidation of DoD data repositories will bring about the following savings:

- *DoD can consolidate wholesale-level technical data repositories.* As CITIS and telecommunications infrastructure capabilities increase, DoD repository consolidation can begin. Most data requests would go directly to the contractor holding the CITIS contract for the data in question. DoD repositories would serve as archives for inactive weapon systems and perhaps as alternate storage sites for active data. DoD data repositories could be centralized into one repository per DoD Component and perhaps eventually into a single DoD repository.
- *Organic support of the weapon system will begin earlier in the acquisition cycle.* That will reduce the ALT for spares procurements by eliminating most intermediate processing of TDPs and bid sets.

Investment Requirements. The following investments are necessary if DoD data repositories are to be consolidated:

- *CITIS contracts.* CITIS would need to be widely available within the contractor community. We assume that DoD will negotiate these contracts directly with the contractors rather than as part of particular weapon system contracts since they would exceed the duration and scope of any particular weapon system contract.
- *Telecommunications costs for on-line access.* Telecommunications costs will partially offset the savings from repository consolidation.

Policy/Regulatory Implications. *Insofar as policy is concerned, DoD must first determine the extent to which its contractors, subcontractors, and vendors will need to* *establish CALS and CITIS capabilities.* Significant resistance to mandatory use of digital data and telecommunications networks to do business with DoD can be expected. DoD will need to decide who will have to have CALS/CITIS capabilities and when they will have to attain them. If significant portions of the supplier community are permitted to remain in a non-CALS environment, procurement activities will need to retain dual capabilities for aperture card or digital outputs and will need to retain more current repository functions as a result.

Proposed Implementation Plan. Negotiate CITIS contracts and resolve small business participation issues, upgrade telecommunications capabilities, and consolidate repositories following broad implementation of CITIS. Repository consolidation is estimated to begin in mid-1998 (see Figure 4-7).

Provisioning

Introduction

Provisioning was selected as a high-payoff process because of the the key role it plays in achieving timely and cost-effective supply support for weapon systems. Direct savings are possible in terms of improving the productivity of provisioning resources and making better provisioning decisions (i.e., decisions that lead to procurement of less inapplicable or excess inventory).

The current provisioning process is highly sequential and requires a significant length of time from the provisioning decision until supply support is achieved. As weapon system design changes occur that affect the items that should be provisioned, design change notices are prepared and sent to the ICPs to notify them of the need to add, change, or delete requirements for individual items being provisioned. The sequential nature of the process often results in the procurement of parts at the same time that design changes are making those same parts not needed. This situation increases the amount of inapplicable or excessive DoD inventory.

By providing better data visibility, CALS can help streamline the provisioning decision process, enable the ICPs to more quickly terminate those provisioning actions that are no longer appropriate, and decrease the time required to establish organic weapon system supply support.

We recommend two CALS applications for provisioning. The first is to implement a system that would permit on-line provisioning reviews and would intelligently search weapon system logistics support analysis records (LSARs) for situations requiring initial supply support actions and subsequent changes. The second is to require that supplementary provisioning technical documentation (SPTD) be submitted in CALS-compliant digital form.

Application 8: Implement Data Review, Analysis, and Monitoring Aid and Include On-line Provisioning

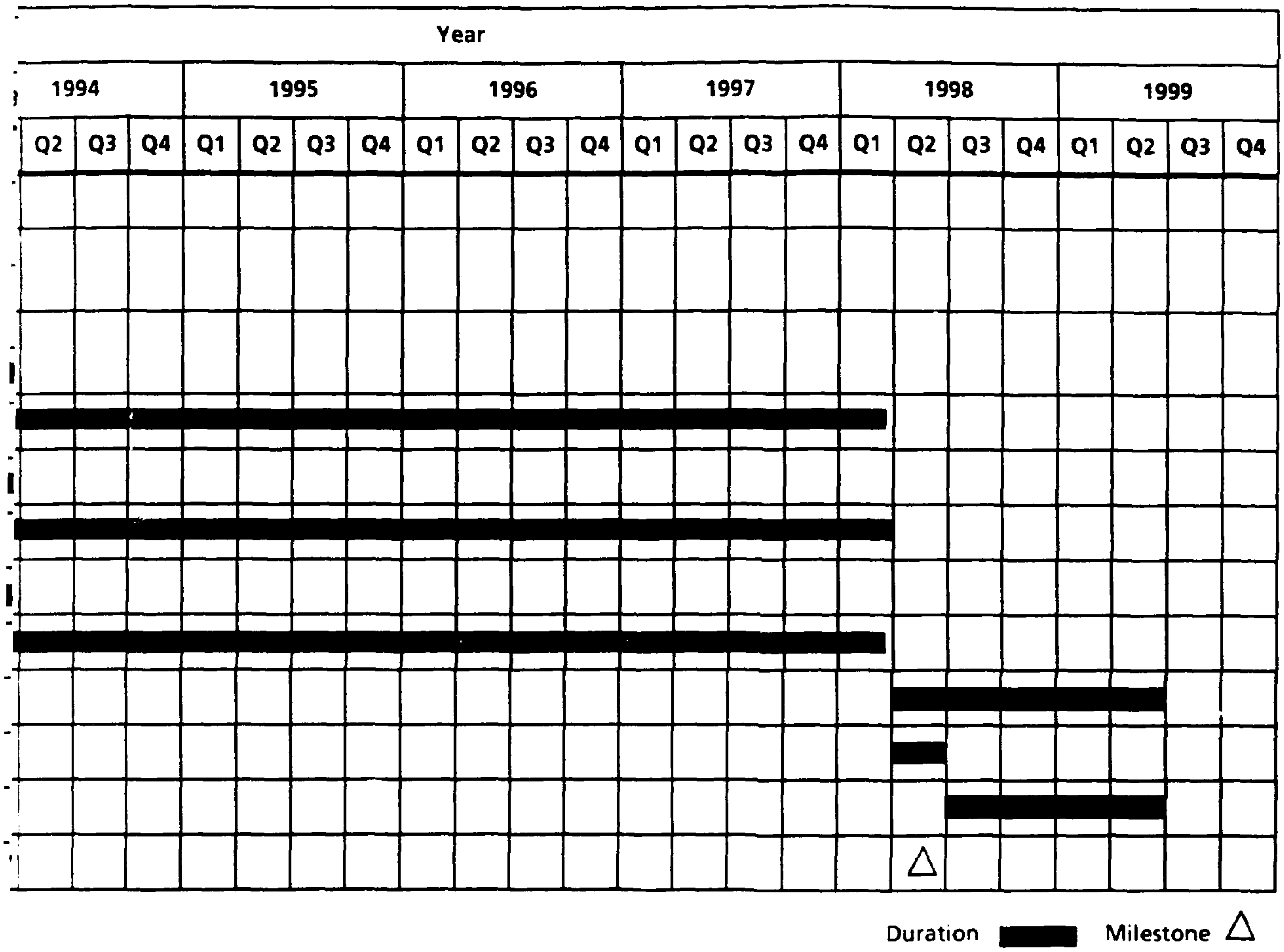
Recommendations. *We recommend that DoD implement an expanded data review, analysis, and monitoring aid (DRAMA) to include on-line provisioning technical review and approval.* The DRAMA is a DLA prototype system to improve existing processes for introducing items (cataloging and provisioning) and requirements determinations. Figure 4-8 shows the current sequential provisioning process. DRAMA uses artificial intelligence and expert systems technology to monitor changes in contractor LSARs. It reports LSAR changes to other DLA systems such as the Standard Automated Materiel Management System (SAMMS) and CTOL. Figure 4-9 shows the concurrent DRAMA provisioning process. Implementation of DRAMA is necessary to make DLA a full partner in the concurrent engineering process for weapon systems acquisition. DRAMA represents automation of a re-engineered logistics process that allows DLA to use better information earlier.

A modified DRAMA can perform on-line provisioning technical review and approval. The Service technical review of provisioning would be initiated by DRAMA once certain criteria in the contractor's LSAR were met. Service approval over a DRAMA screen would then initiate the next action; Service disapproval or comment would create a notification transaction to the contractor. The requirement for this functionality should be forwarded to the DRAMA Functional Working Group.

Prerequisites. The prototype system successfully passed a proof of concept test as part of the C-17 aircraft acquisition program. As a prerequisite to conversion of the prototype and deployment of DRAMA as a production system, DLA is conducting a functional economic analysis (FEA) and business area analysis (BAA) of DRAMA. The General Services Administration will administer the contract for these analyses. The schedule for awarding and performing the contract is not available. After these analyses, DLA would acquire the hardware and software to deploy a production DRAMA system. Another prerequisite is the cultural change needed to recognize DLA's large and increasing role in weapon systems support. Although in the past the

Task	Action office(s)	1992	1993				1994				1	
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Policy												
Determine CITIS acquisition strategy	DoD CALS, USD(A), Services, PMs, DLA											
Determine thresholds for contractor participation	USD(A), DoD CALS, Services, DLA											
Infrastructure												
Negotiate CITIS contracts	DoD CALS, Services											
Upgrade telecommunications capability												
Submit requirements to DISA	DoD CALS											
Install telecommunications capability	DISA											
Consolidate DoD data repositories												
Establish consolidation schedule	Services, DLA											
Implement consolidation	Services, DLA											
Implement application												

FIG. 4-7. DoD DATA REPOSITORY CONS(



ATA REPOSITORY CONSOLIDATION

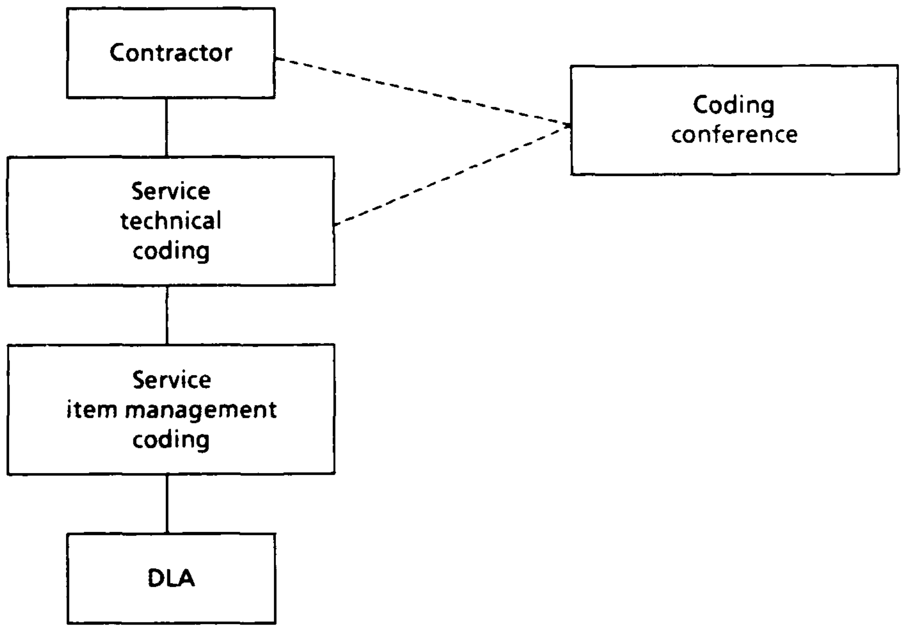


FIG. 4-8. SEQUENTIAL PROVISIONING PROCESS (TODAY)

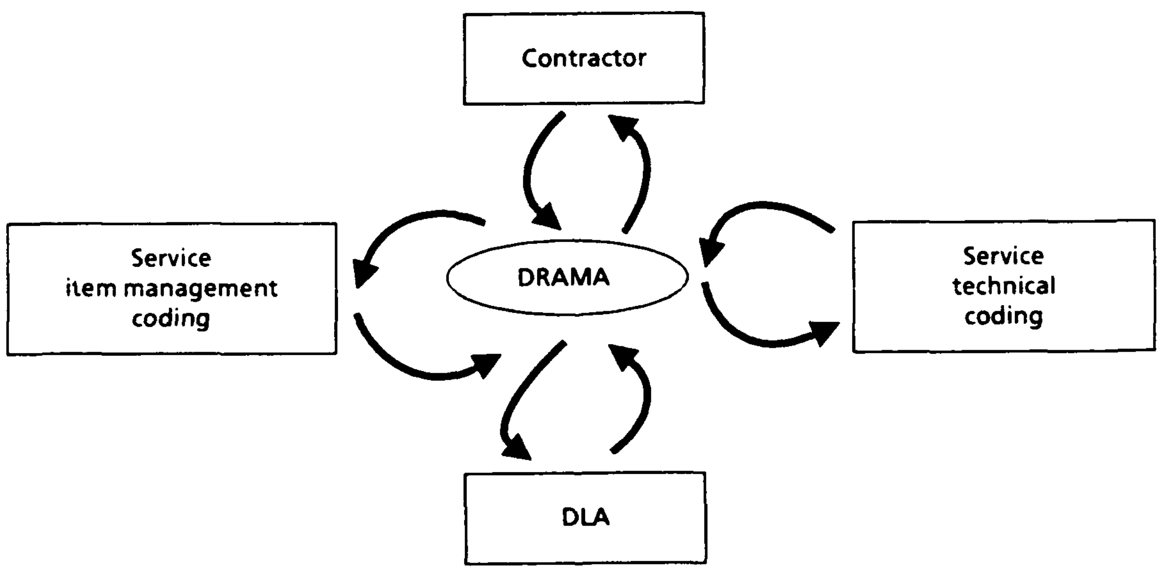


FIG. 4-9. CONCURRENT PROVISIONING PROCESS (DRAMA)

Services have been reluctant to recognize DLA's role in weapon system support, DLA's support is large and growing as the result of several Defense Management Report Decisions.

Schedule Impacts. By using better information earlier, DRAMA will enable DoD to reduce the time needed to get the weapon system support in place. For that reason, the commitment to purchase new spare parts for inventory can be deferred until the weapon system design is stabilized without jeopardizing timely support for the weapon system.

Savings Impacts. The details of savings must await the FEA and BAA. However, the potential savings areas for DRAMA include the following:

- *Item introduction.* DRAMA screens LSAR data bases for completeness, automatically informing contractors of missing or erroneous data and of items already supported. Thus, the Services and DLA, working in coordination with the concurrent engineering team, can more effectively influence supportability of weapon system design.

- *Supply management.* DRAMA monitors supportability of supply support requests (SSRs) to verify that information on those SSRs is consistent with the latest information available from the LSAR. When the information is found to be outdated, DRAMA flags the SSR and DLA contacts the Service for clarification. DRAMA also monitors interim and final advice on SSRs. DLA can use those results to notify the Service and the contractor that they are using different assumptions for support requirements. DRAMA also reviews recommended buys from SAMMS to verify that they are consistent with the latest information available in the LSAR. Thus, the DRAMA ensures that DLA support is closely aligned with current support requirements. The results are that the procurement of provisioned inapplicable assets will be greatly reduced. From our savings estimates we have assumed a 20 percent reduction. That reduction equates to an annual DoD-wide savings of approximately $7 million (see Table 4-2).

Investment Requirements. The investment required for this application consists of the following:

- Modification and implementation of DRAMA

- Telecommunications.

TABLE 4-2

PROVISIONING SAVINGS COMPUTATION

Sources of savings	
Source: Federal Supply Class (FSC) *Quality Status Report* RCS: DLSC[M763(F)] dated 24 July 1992	• Roughly 38,000 new fully described NSN items enter the DoD supply system each year. • Roughly 50,000 new partially described NSN items enter the DoD supply system each year. • Roughly 22,000 new reference-type NSN items enter the DoD supply system each year. • Therefore: Approximately 110,000 new items each year. • A total of 4,787,827 NSN items are currently in the DoD catalog (i.e., the total NSN item population).
Source: Unpublished LMI study	• One-third of all on-hand DoD assets are inapplicable. • Roughly 4 percent of those are *provisioned* inapplicable (i.e., never experienced any demand).
Source: *DoD Supply Systems Inventory Report,* 30 September 1991	• Total inventory value in 1990 was $101.7 billion. • Therefore, the value of provisioned inapplicable inventory = $101.7 billion x 0.33 inapplicable assets x 0.04 provisioned inapplicable assets = <u>$1.34 billion</u>.
Source: *SSR Status Report*	• Approximately 52 percent of new NSN items are stocked. • Therefore: The number of stocked NSN items = 4,787,827 total NSN items x 0.52 stocked NSN items = <u>2,489,670 stocked NSN items</u>. • Therefore: The average value of stocked NSN items = $101.7 billion/2,489,670 NSN items = <u>$40,848 per stocked NSN item</u>. • Therefore: The number of new stocked NSN items per year = 110,000 NSN items x 0.52 stocked NSN items = <u>57,200 newly stocked NSN items per year</u>.

Note: DLSC = Defense Logistics Services Center.

TABLE 4-2

PROVISIONING SAVINGS COMPUTATION (Continued)

Sources of savings	
Source: *SSR Status Report* (Continued)	• Therefore: The number of NSN items provisioned inapplicable = 57,200 new stocked NSN items x 0.33 inapplicable assets x0.04 provisioned inapplicable assets = 755 NSN items provisioned inapplicable. • Therefore: The value of provisioned inapplicable buys = 755 NSN items x $40, 848 per NSN item = $30,840,240 of provisioned inapplicable material bought annually.
Source: *Multiple Cost Economic Order Quantity (EOQ) Study*	• Average cost per order = $1,331. • Therefore, labor cost to procure inapplicable inventory = 755 NSN items x $1,331 per order = $1,004,905 labor cost.
Savings	
DoD savings from implementing on-line provisioning/DRAMA	• Assume: CALS (on-line provisioning and DRAMA) decreases provisioning errors by 20 percent. • Therefore, direct inventory savings from on-line provisioning/DRAMA = 0.20 error reduction x $30,840,240 value of provisioned inapplicable buys = $6,168,048 cost avoidance in inapplicable inventory buys per year. • Additional holding costs avoided = $6,168,048 value of buys avoided x 0.01 holding cost = $61,680 holding costs avoided per year. • Therefore, total savings from implementing on-line provisioning/DRAMA = $6,168,048 + $1,004,905 + $61,680 = approximately $7.2 million per year in cost avoidance.

Note: DLSC = Defense Logistics Services Center.

Policy/Regulatory Implications. The Services and DLA would have to implement policies to promote DLA's full participation in weapon system support decisions. MIL-HDBK-59A should be the vehicle for that policy.

Proposed Implementation Plan. DRAMA (Phase 1) is scheduled to be implemented within DLA in FY94. The requirement to include Service on-line provisioning review and approval should be forwarded to the DRAMA Functional Working Group (see Figure 4-10).

Task	Action office(s)	Year										
		1992	1993				1994				1995	
		Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2
Modify DRAMA to include on-line provisioning		■	■	■	■	■						
Forward requirements to DRAMA Functional Working Group	DoD CALS	■										
Modify DRAMA	DRAMA Functional Working Group		■	■	■	■						
Change policies and procedures		■	■	■	■	■						
Forward recommended provisioning changes	DoD CALS	■										
Change policy directives and standards	ASD(P&L)		■	■	■	■						
Implement DRAMA	DLA	■	■	■	■	■	■	■	■	■		
Implement application										Δ		
Modify contract requirements	PMs									■	■	■

Duration ■ Milestone Δ

Note: ASD(P&L) = Assistant Secretary of Defense for Production and Logistics.

FIG. 4-10. IMPLEMENT DRAMA/ON-LINE PROVISIONING

Application 9: Digitize Supplementary Provisioning Technical Documentation

Recommendations. *We recommend SPTD be digitized.* Under the current provisioning process, SPTD is procured from the contractor in either hard copy or aperture card formats. These data, usually in the form of a monodetail drawing or catalog page, are used by the cataloger for item identification. With the advent of CTOL, the SPTD is scanned onto optical storage disks and is then called to the cataloger's screen.

The proposed change would require the contractor to submit SPTD in a CALS-compliant digital format, which would eliminate the scanning process.

The SPTD differs from the TDP primarily in the timing in the acquisition cycle. SPTD is preliminary technical data generated during the EMD phase and is meant to support provisioning and not manufacturing of the item. Therefore, it is focused primarily on describing the item (dimensions, tolerances, color, etc.) rather than manufacturing processes. SPTD often consists of a tear-sheet from a parts catalog or an engineering drawing that may or may not have manufacturing processes annotated on it. TDPs, on the other hand, are delivered in the production phase and include all engineering drawings and other associated lists needed by a competent manufacturer to produce the part.

Prerequisites. CTOL would need to be modified to accept CALS-compliant digital SPTD input.

Schedule Impacts. This recommendation would speed up the SSR process. Today, the Services electronically submit SSRs to DLA, but the associated SPTD is mailed to the Defense Electronics Supply Center (DESC) which, in turn, separates and mails the drawings to the DLA ICP responsible for the item. Once received by the applicable ICP, the SPTD must be scanned and combined with the appropriate SSR to continue the supply support process.

Under the CALS concept, the SPTD would be electronically transmitted directly to the appropriate ICP, eliminating weeks of unnecessary delay for distribution and scanning.

Savings Impacts. Savings in labor costs associated with SPTD distribution would be avoided.

Investment Requirements. This application would require investments to do two things:

- Modify CTOL
- Digitize and convert SPTD not already in CALS-compliant digital format.

Policy/Regulatory Implications. Insofar as policy is concerned, MIL-STD-1561B (*Provisioning Procedures, Uniform Department of Defense*), Section 5.3.13.2, SPTD Submission, would have to be changed to permit submission in CALS raster graphic (Military Specification MIL-R-28002) format.

Proposed Implementation Plan. To implement our recommendation, DoD must revise MIL-STD-1561B and modify CTOL to accept digital SPTD. Once those modifications are complete, contracts should require digital SPTD delivery. Implementation is estimated in late 1993 (see Figure 4-11).

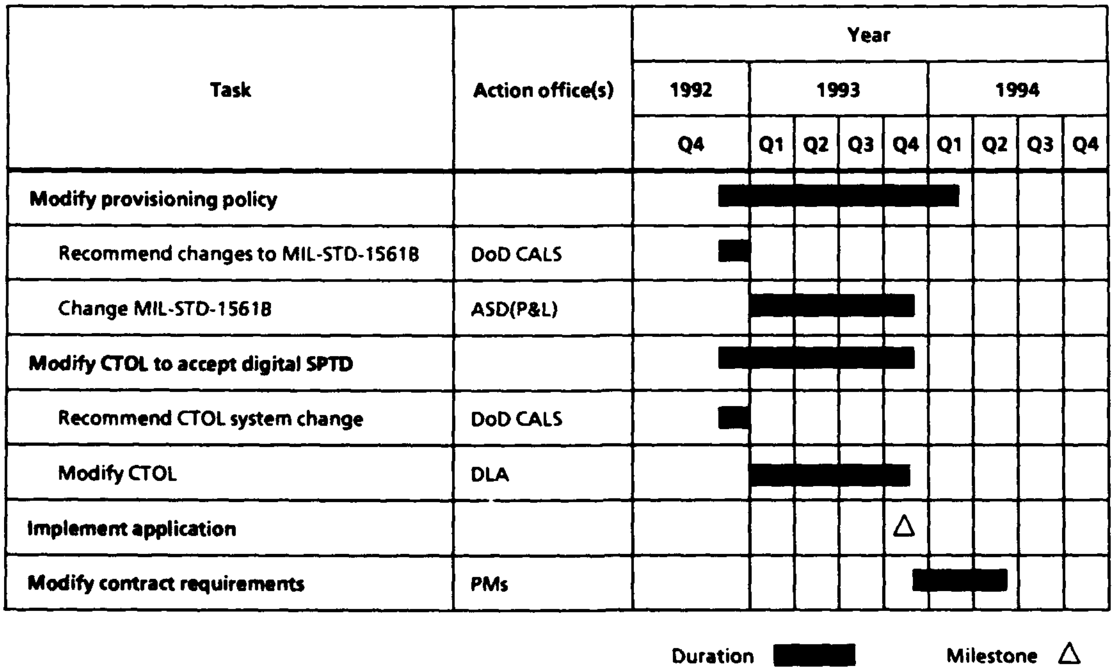


FIG. 4-11. DIGITIZE SUPPLEMENTARY PROVISIONING TECHNICAL DOCUMENTATION

CHAPTER 5

RECOMMENDATIONS

In this chapter, we summarize our recommendations to the Defense CALS Executive.

IMPLEMENTING CALS APPLICATIONS

Recommendation: ***Implement the nine CALS applications proposed in this report to improve the DoD weapon system acquisition process.***

A conservative estimate of savings for these nine applications is $160 million a year. These applications would establish CALS capabilities that could be used to improve other processes as well, resulting in further savings. The recommended applications would be cost-effective even when telecommunications and implementation costs for modifying and integrating existing information systems and converting legacy data are taken into account.

Recommendation: ***Coordinate closely with functional managers to revise functional policy and procedure while implementing CALS applications.***

The proposed CALS applications would require changes in business processes before most savings could be realized. We identify the responsible functional managers in our previous description of each proposed application.

Recommendation: ***Emphasize infrastructure modernization (e.g., JCALS, JEDMICS, CITIS, telecommunications improvements) as being essential to DoD-wide CALS implementation.***

Before implementing our proposed applications, DoD must modernize its infrastructure (hardware, software, and telecommunications capacity) to support digital processing of data from the contractor to the program manager to the supporting activities and back to industry. Joint CALS, the Joint Engineering Data Management and Information Control System (JEDMICS), and the Contractor Integrated Technical Information Service (CITIS) are major parts of this infrastructure modernization.

Recommendation: ***Coordinate requirements for CALS-compliant digital delivery with the infrastructure's capability to receive and process it.***

A good portion of the DoD infrastructure must be in place to gain the expected benefits from CALS applications. Any time digital data must be reduced to paper or microform for continued processing or must be re-entered into another system, much of the anticipated value from the CALS application is lost.

Recommendation: ***Avoid further proof-of-concept prototyping for CALS digital data exchange.***

The feasibility of digital data exchange concepts has been adequately proved; DoD needs the initial infrastructure investment and functional manager support. CALS prototypes in weapon system programs should now focus on developing CALS Phase II (i.e., data base integration) technology and standards.

Recommendation: ***Advise functional managers of anticipated volume reduction in the number of design changes and other workload indicators for supporting activities.***

Potential improvements that CALS can bring about in the acquisition process and concurrent engineering advances show promise of significantly reducing the workload of supporting activities as the number of design changes decreases and weapon system designs become more supportable. Supporting activities will need to know the estimated extent of that reduction to plan economic work processes and information systems.

Recommendation: ***Coordinate closely with JLSC to ensure acquisition systems interface adequately with standard logistics systems.***

CALS capabilities need to be considered as JLSC/CIM establish standard logistics systems, and acquisition programs need to acquire the correct data in the correct format to support logistics system operations.

Recommendation: ***Review DoD plans to convert legacy data for potential cost savings.***

Many engineering drawings are stored in multiple repositories within DoD with varying degrees of legibility. A systematic approach to conversion of existing non-CALS-compliant technical data that considers the best sources of data for conversion and the least-cost conversion options on a DoD-wide basis would be more cost-effective than allowing each repository to plan its own conversion.

FUNCTIONAL ECONOMIC ANALYSIS

Recommendation: ***Ensure that CALS applications consider full life-cycle impacts.***

While lowering overall weapon system life-cycle costs, the CALS implementation will tend to shift costs forward in the cycle and to shift savings later in the cycle. Unless potential CALS users consider full life-cycle benefits, many CALS applications will likely appear unattractive to them. Contract incentives and milestone review criteria can help provide a broader view to decision makers early in the life cycle.

Recommendation: ***Identify and begin collecting key costs and activity-level indicators that are critical to setting priorities for CALS applications and evaluating them.***

Baselines should be established for 5 to 10 key performance indicators and those indicators should be tracked to measure the progress and success of CALS implementation. If the estimated benefits from CALS are achieved, the key performance indicators (number of ECPs reviewed, number of DCNs processed, and length of time to fill data requests, for example) should decline. Unfortunately, data for many of these basic indicators are either not collected or are not aggregated to the DoD level today. The Defense CALS Executive (DCE) should identify a small number of such indicators; work with OSD counterparts in ASD(P&L), DDR&E, and USD(A) to establish cost-effective means of gathering and using the data; and include such indicators in future economic analyses and program evaluations for CALS applications.

Recommendation: ***Review DoD funding mechanisms in light of process changes.***

Since many of the benefits of CALS applications will accrue later in the life cycle, some of the funding saved should perhaps be shifted earlier in the life cycle (to acquisition) to support higher CALS costs in the earlier phases. Also, with logistics and production personnel taking a more active role earlier in the life cycle, appropriate procurement and operations and maintenance (O&M) funding will be needed earlier as well.

DIGITAL DATA EXCHANGE STANDARDS

Recommendation: ***Refine and approve existing CALS digital data exchange standards.***

Refining and approving the CALS standards will encourage vendor development of CALS-compliant products and will facilitate incorporation of CALS requirements in weapon system contracts.

Recommendation: ***Take the standards actions outlined in Appendix H.***

Recommendation: ***Begin development of implementation guides for the CALS data exchange standards.***

Too much trading partner negotiation is required to exchange digital data, even with CALS standards in place. CALS needs a series of implementation guides similar to those for EDI that provide additional guidance to both DoD and contractors for exchanging data for specific transactions or processes.

ACQUISITION GUIDANCE

Recommendation: ***Revise MIL-HDBK-59A per Appendix J.***

Recommendation: ***Strengthen CALS guidance contained in DoDI 5000.2 and the DFARS.***

Guidance on CALS in DoDI 5000.2 generally states that contracts should use CALS. That language should be strengthened to replace "should" with "shall." DFARS clause 207.105(b)(12)(S-70) should require acquisition plans to include a CALS implementation plan rather than merely a description of the extent of CALS implementation.

CONTRACT INCENTIVES

Recommendation: ***Use cost plus incentive fee (CPIF), cost plus award fee (CPAF), and value engineering (VE) as contract incentives.***

Either CPIF or CPAF contracts can be used in all phases of the acquisition process to allow contractors and program managers to share cost savings achieved through CALS implementation. VE clauses can be mandatory or optional and consider the life-cycle savings of a CALS application.

GENERAL

Recommendation: ***Promote CALS as an integral part of the new DoD weapon system acquisition strategy.***

The new strategy will require CALS capabilities to enable a quick assessment of technical data from the development effort (perhaps by a contractor other than the developer), to do any necessary redesign, and to put the system into production. CALS can also be effectively applied to modifications to extend the life of existing systems as fewer new systems are fielded.

Recommendation: ***Capture "lessons learned" from previous CALS prototype applications.***

Even though numerous CALS or CALS-like prototypes have been initiated by various weapon system programs, no readily available catalog of the projects provides their descriptions, costs and benefits, operational experience, and "lessons learned." Such a catalog would allow DoD to obtain greater benefit from the experience gained by the various programs, more easily identify solutions that could be adapted for DoD-wide use, and obtain useful feedback for refinement of CALS data exchange standards.

Recommendation: ***Conduct detailed case studies of selected CALS prototype applications.***

Based on the information gathered for the "lessons learned" catalog, two or three prototypes should be selected for in-depth study to help develop cost and savings estimates for other projects and to establish the basis for expanding the prototypes into DoD-wide applications.

Recommendation: ***Include Defense Logistics Agency participation in the development and implementation of CALS applications for weapon system acquisition.***

As DLA accumulates greater weapon system supply support responsibilities, it should play an increasing role in development decisions that have primarily been in the program manager or Service domain.

Recommendation: ***Consider implementation of CALS Phase I (i.e., digital data exchange) as the prelude to CALS Phase II (data base integration).***

In addition to the immediate savings offered by implementing CALS applications with today's Phase I standards, DoD would gain operating experience in the digital environment that would help prepare the way for the introduction of Phase II standards. Data base integration is expected to offer even greater opportunities for process re-engineering and consolidation of functions.

Recommendation: ***Coordinate a DoD position with the USD(A) on small business participation in CALS.***

The scope and economics of CALS applications will be affected by the extent to which small business is required to participate. If small business is required to have CALS capability to do business with DoD, low-end options must be designed into CALS applications to permit small businesses to participate cost-effectively. If small businesses are exempted from CALS, many DoD activities will be required to operate dual-capability systems that function in either a CALS or non-CALS environment (e.g., engineering drawings on optical disk and on aperture cards).

GLOSSARY

ACAT	=	acquisition category
ALT	=	administrative lead time
ASD(P&L)	=	Assistant Secretary of Defense for Production and Logistics
BAA	=	business area analysis
CAD	=	computer-aided design
CALS	=	Computer-aided Acquisition and Logistics Support
CAM	=	computer-aided manufacturing
CCB	=	configuration control board
CDRL	=	contract data requirements list
CE/D	=	concept exploration and definition
CIM	=	corporate information management
CITIS	=	Contractor Integrated Technical Information Service
CLIP	=	Configuration and Logistics Information Program
CM	=	configuration management
CPAF	=	cost plus award fee
CPIF	=	cost plus incentive fee
CTOL	=	Cataloging Tools On-Line
DAB	=	Defense Acquisition Board
DCE	=	Defense CALS Executive
DCN	=	design change notice
DDR&E	=	Director of Defense Research and Engineering
dem/val	=	demonstration/validation
DESC	=	Defense Electronics Supply Center

DFARS	=	Defense Federal Acquisition Regulations Supplement
DISA	=	Defense Information Systems Agency
DLA	=	Defense Logistics Agency
DLSC	=	Defense Logistics Services Center
DMR	=	Defense Management Review
DMRD	=	defense management report decisions
DoDD	=	DoD Directive
DoDI	=	DoD Instruction
DoD-STD	=	DoD Standard
DRAMA	=	Data Review, Analysis, and Monitoring Aid
DSB	=	Defense Science Board
ECP	=	engineering change proposal
EDI	=	electronic data interchange
EMD	=	engineering and manufacturing development
EOQ	=	economic order quantity
FEA	=	functional economic analysis
FSC	=	Federal Supply Class
FSD	=	full-scale development
GFE	=	Government-furnished equipment
ICP	=	inventory control point
IETM	=	interactive electronic technical manual
ILS	=	integrated logistics support
IMIP	=	Industrial Modernization Incentives Program
IOC	=	initial operating capability
IPPD	=	integrated product/process development
IPR	=	in-process review
IWSDB	=	integrated weapon system data base

JCALS	=	Joint Computer-aided Acquisition and Logistics Support
JCS	=	Joint Chiefs of Staff
JEDMICS	=	Joint Engineering Data Management and Information Control System
JLSC	=	Joint Logistics Systems Command
LAN	=	local area network
LMI	=	Logistics Management Institute
LOGRUN	=	Logistics Remote User Network
LSA	=	logistics support analysis
LSAR	=	logistics support analysis record
MA	=	mission and threat analysis
MANTECH	=	manufacturing technology
MEARS	=	Multi-User Engineering Change Proposal Automated Review System
MIL-_	=	Military Specification
MILCON	=	military construction
MIL-HDBK	=	Military Handbook
MIL-STD	=	Military Standard
MODMIS	=	Modification Management Information System
MPCAG	=	Military Parts Control Advisory Group
MPCASS	=	Military Parts Control Automated Support System
MPTS	=	manpower, personnel, training, and safety
NAVAIR	=	Naval Air Systems Command
NSN	=	National Stock Number
OGA	=	other Government agencies
O&M	=	operations and maintenance
PC	=	personal computer

PDES	=	product data exchange using STEP
PMO	=	program management office
QA	=	quality assurance
RDT&E	=	research, development, test and evaluation
SAIC	=	Science Applications International Corporation
SAMMS	=	Standard Automated Materiel Management System
SAR	=	*Selected Acquisition Report*
SLEP	=	Service Life Extension Program
SPTD	=	supplementary provisioning technical documentation
SSR	=	supply support request
STEP	=	Standard for the Exchange of Product Model Data
TASC	=	The Analytic Sciences Corporation
TDP	=	technical data package
T&E	=	test and evaluation
TM	=	technical manual
USD(A)	=	Under Secretary of Defense (Acquisition)
VE	=	value engineering

APPENDIX A

POTENTIAL IMPACT OF COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT ON HIGH-PAYOFF TARGET FUNCTIONS

POTENTIAL IMPACT OF COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT ON HIGH-PAYOFF TARGET FUNCTIONS

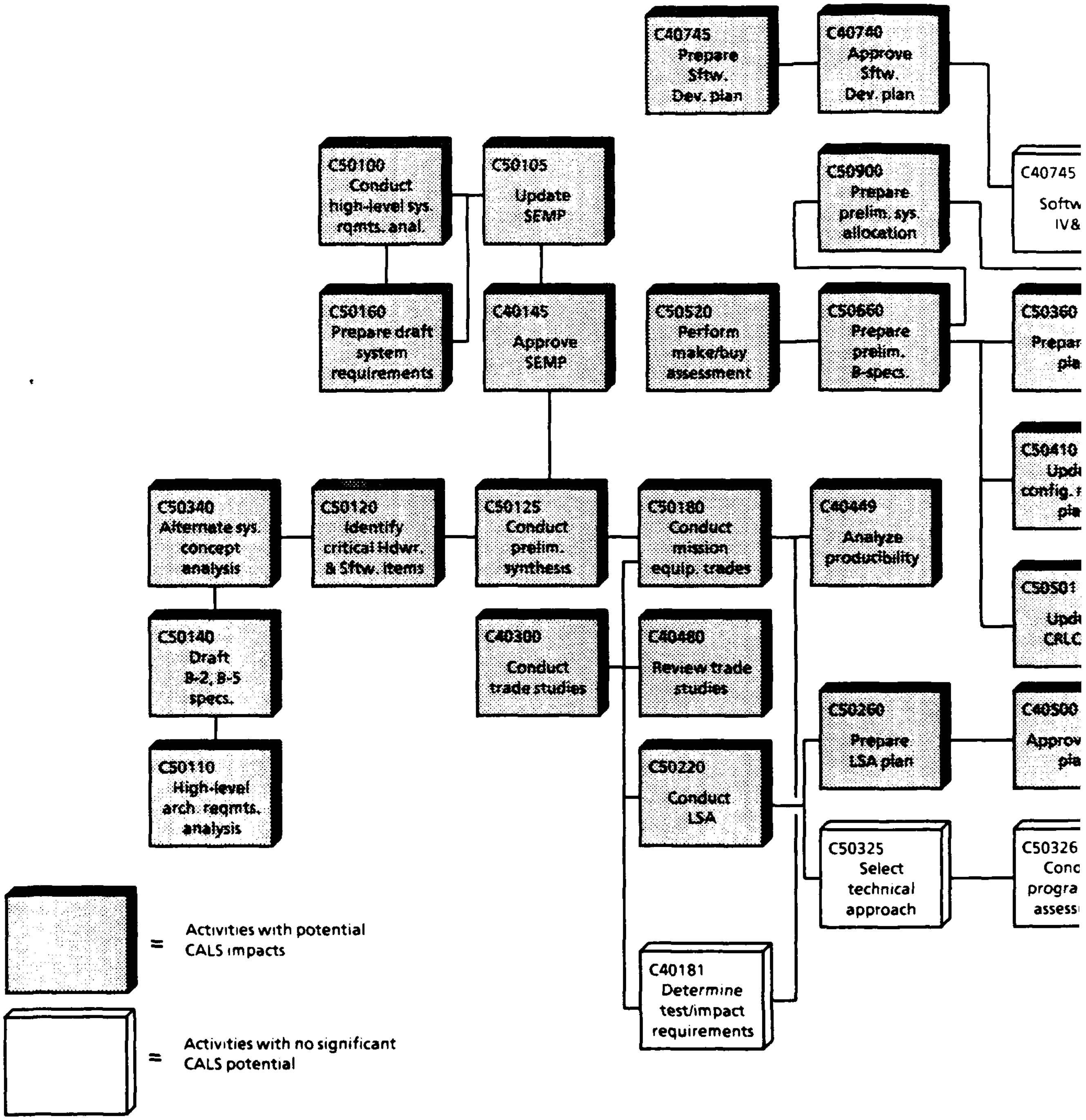
Activities in the engineering and configuration management, test and evaluation, and manufacturing functional areas of the demonstration and validation (dem/val) and the engineering and manufacturing development (EMD) phases of the acquisition process are presented in this appendix.[1] The activities are presented in a logical flow based on activities which must precede or succeed each other.

The shaded activities in Figures A-1 through A-6 are those that could be improved through the implementation of the following CALS technologies:

- Automated review and approval
- Electronic access to contract data requirements list (CDRL) data
- Access to contractor analysis tools
- Electronic data interchange (EDI)
- Digital data delivery
- Concurrent engineering.

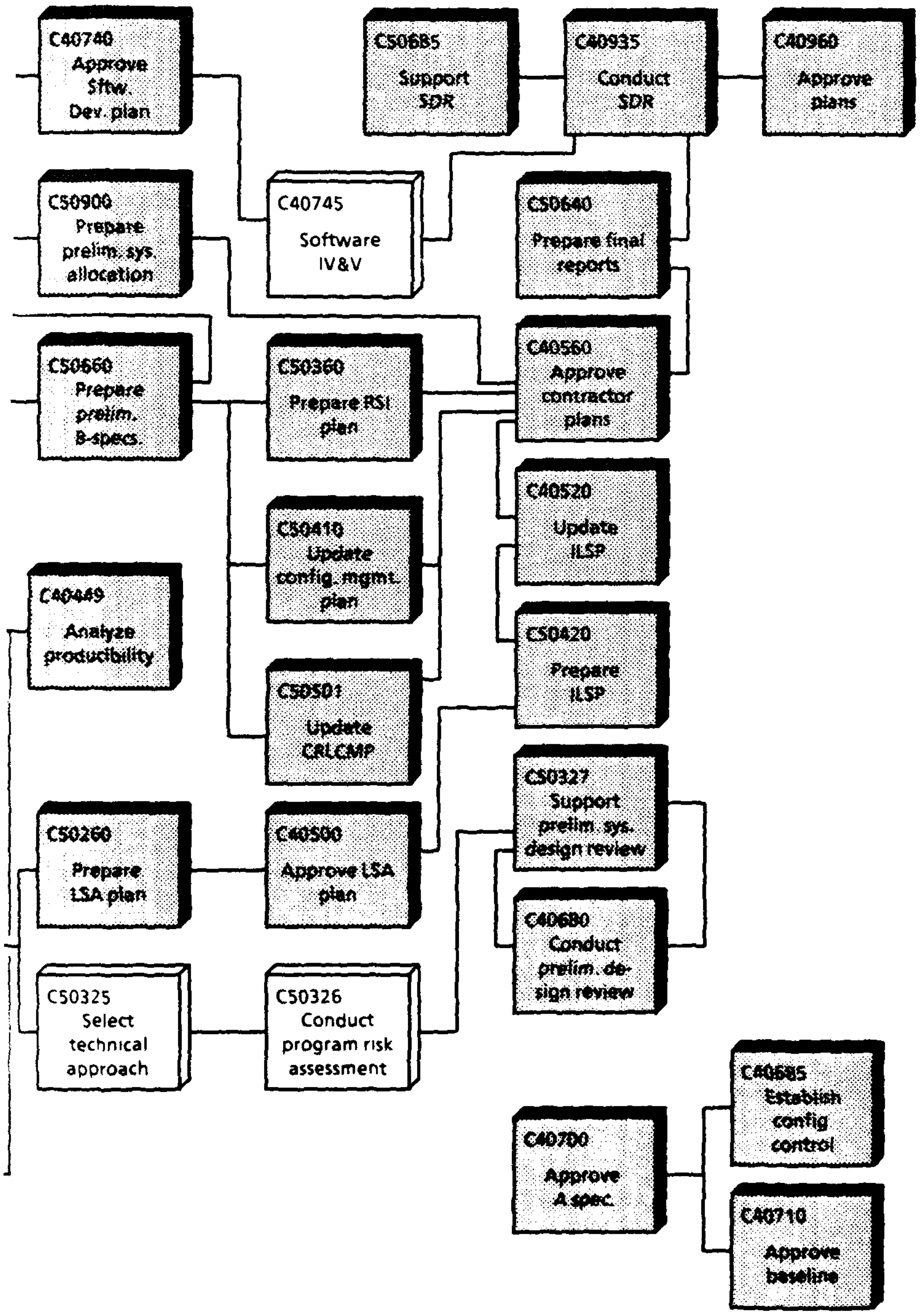
The shaded activities were determined on the basis of their near-term potential (within 5 years). No attempt was made to re-engineer the processes by combining or eliminating activities. Thus, the shaded boxes present a conservative assessment of potential CALS impacts.

[1]Activities and functions are drawn from the acquisition process model. Activity numbers shown in this appendix are those assigned in the model.



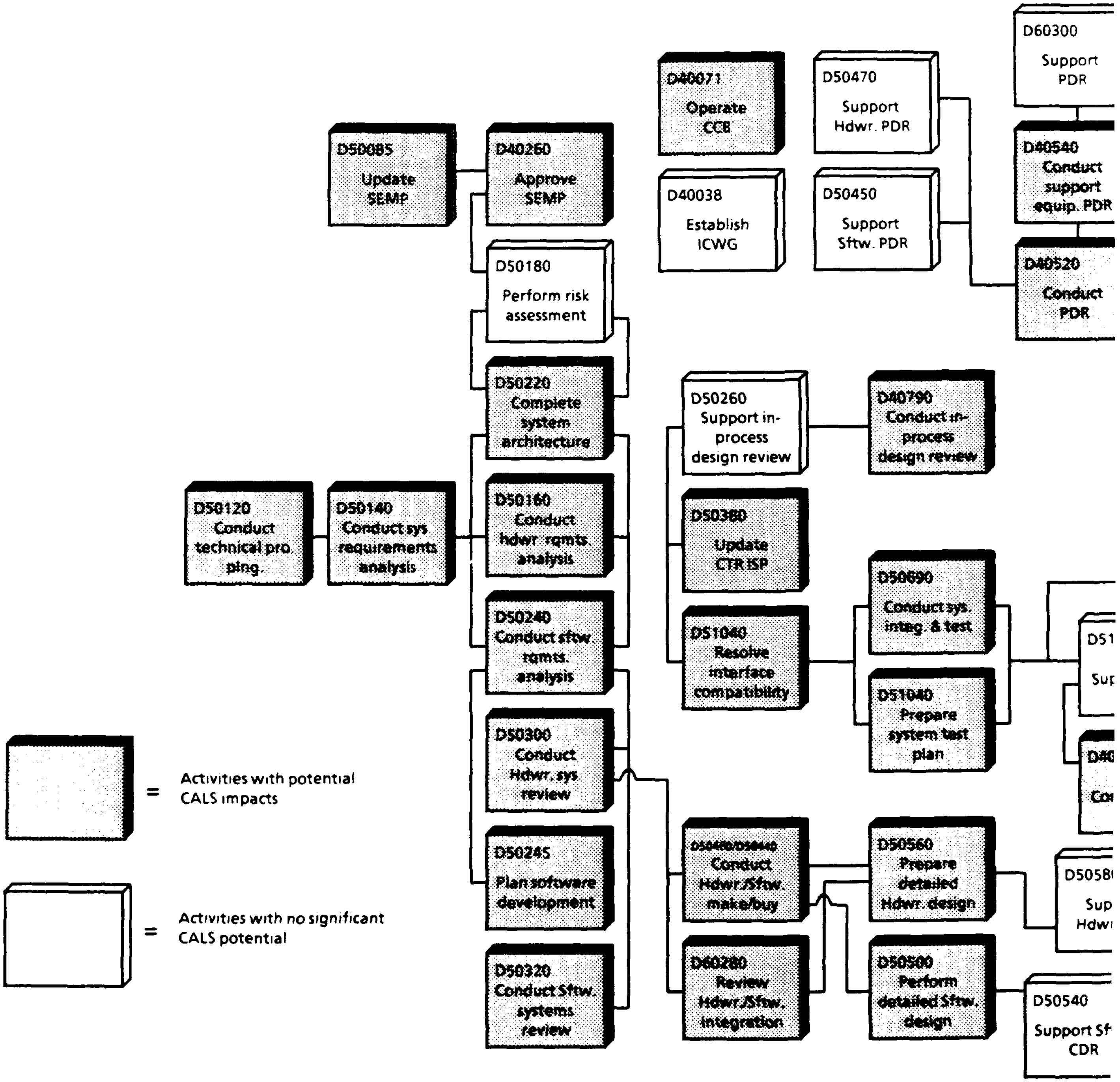
Notes: SEMP = systems engineering management plan; LSA = logistics support analysis; IV&V = independent verification and validatio resources life-cycle management plan; SDR = system design review; ILSP = integrated logistics support plan.

FIG. A-1. ENGINEERING ACTIVITIES – DEMONSTRATION/VALI



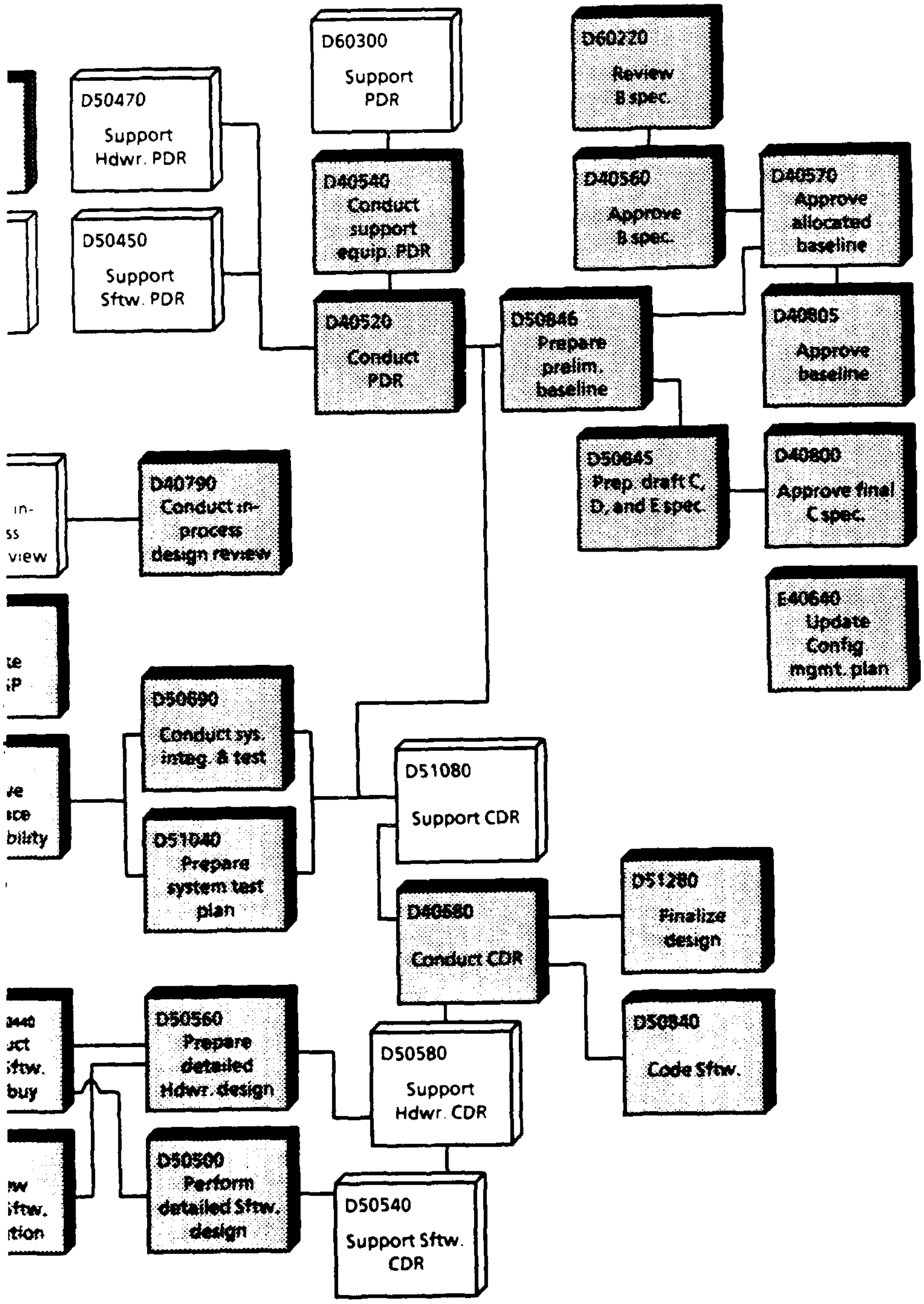
ndependent verification and validation; RSI = rationalization, standardization, and interoperability; CRLCMP = computer
n

TIES – DEMONSTRATION/VALIDATION PHASE



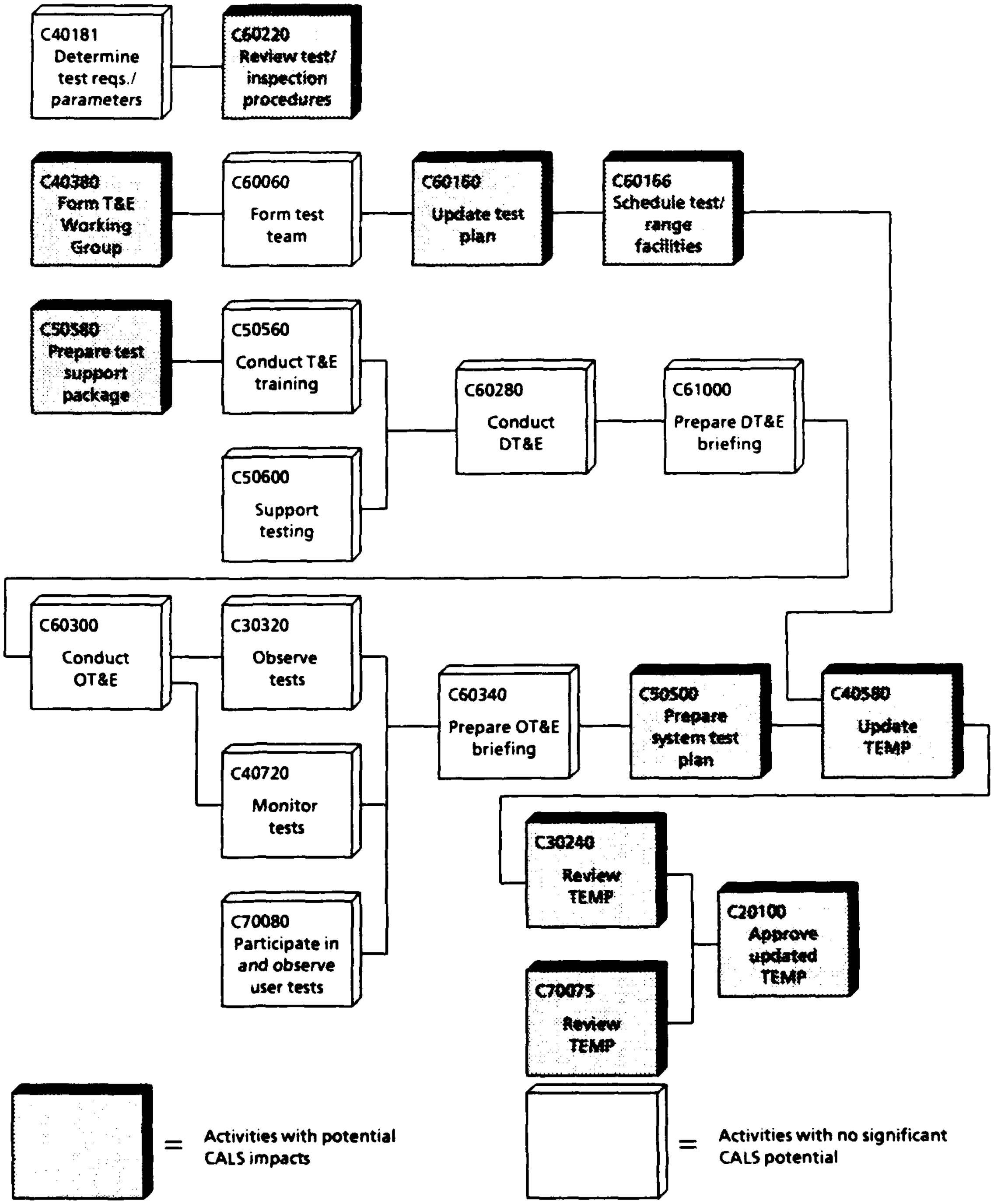
Notes: CCB = configuration control board; ICWG = interface control working group; CTR ISP = contractor interim support plan; PDR = preliminary de

FIG. A-2. ENGINEERING ACTIVITIES – ENGINEERING AND MANUFACTURING DE



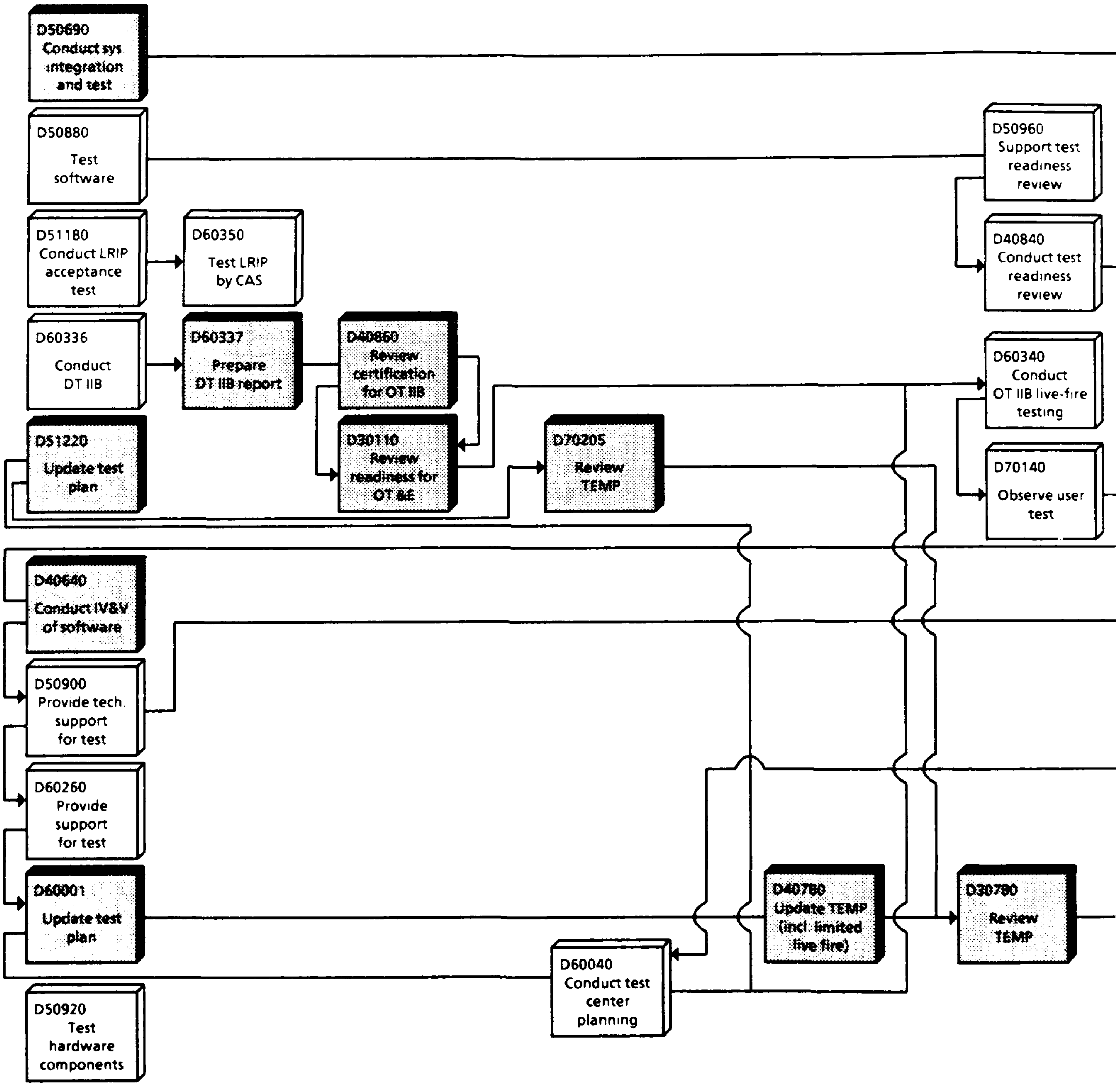
ractor interim support plan; PDR = preliminary design review.

INEERING AND MANUFACTURING DEVELOPMENT PHASE



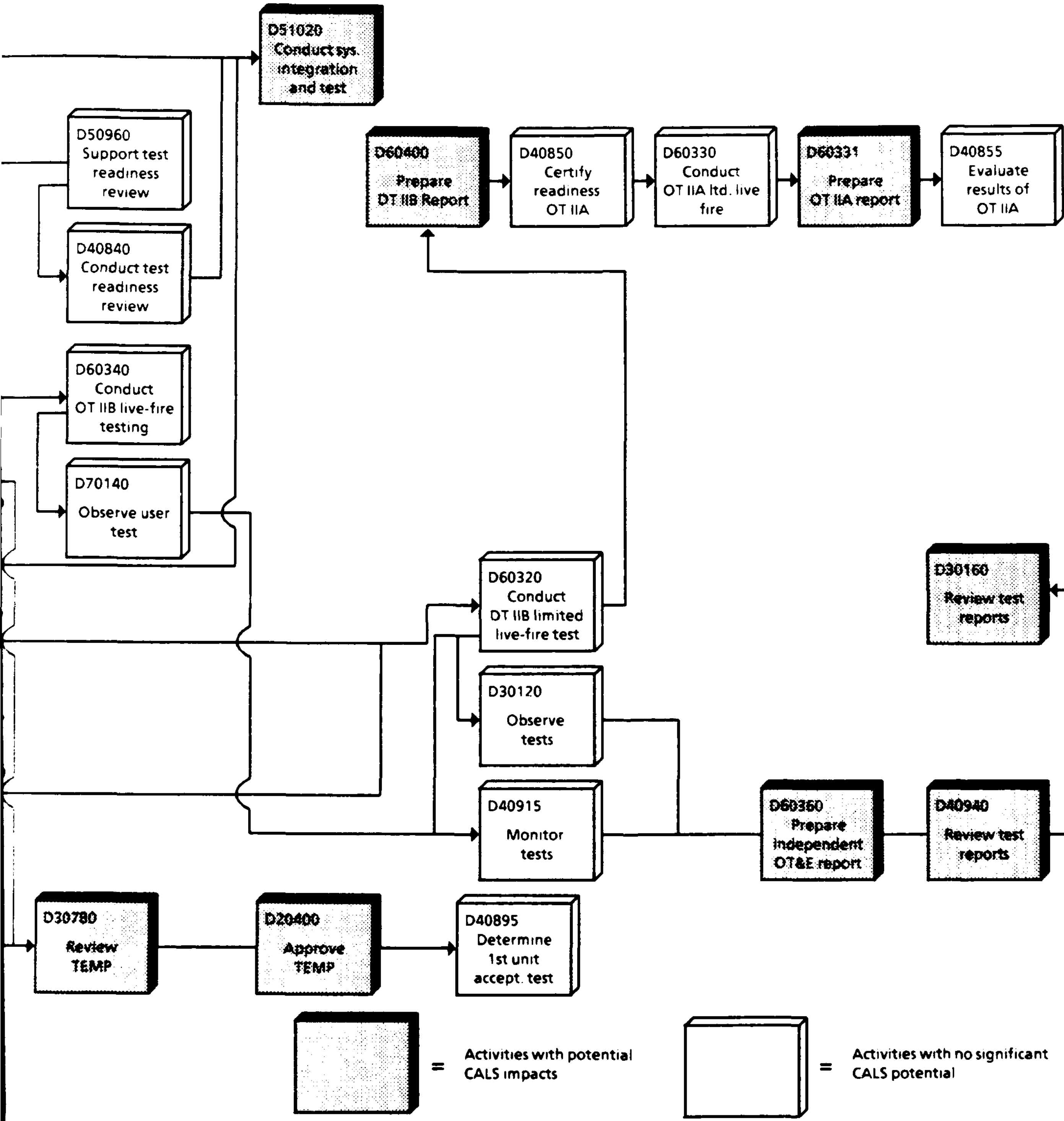
Notes: T&E = test and evaluation; TEMP = test and evaluation master plan; DT&E = design T&E; OT&E = operational T&E.

FIG. A-3. TEST AND EVALUATION – DEMONSTRATION/VALIDATION PHASE



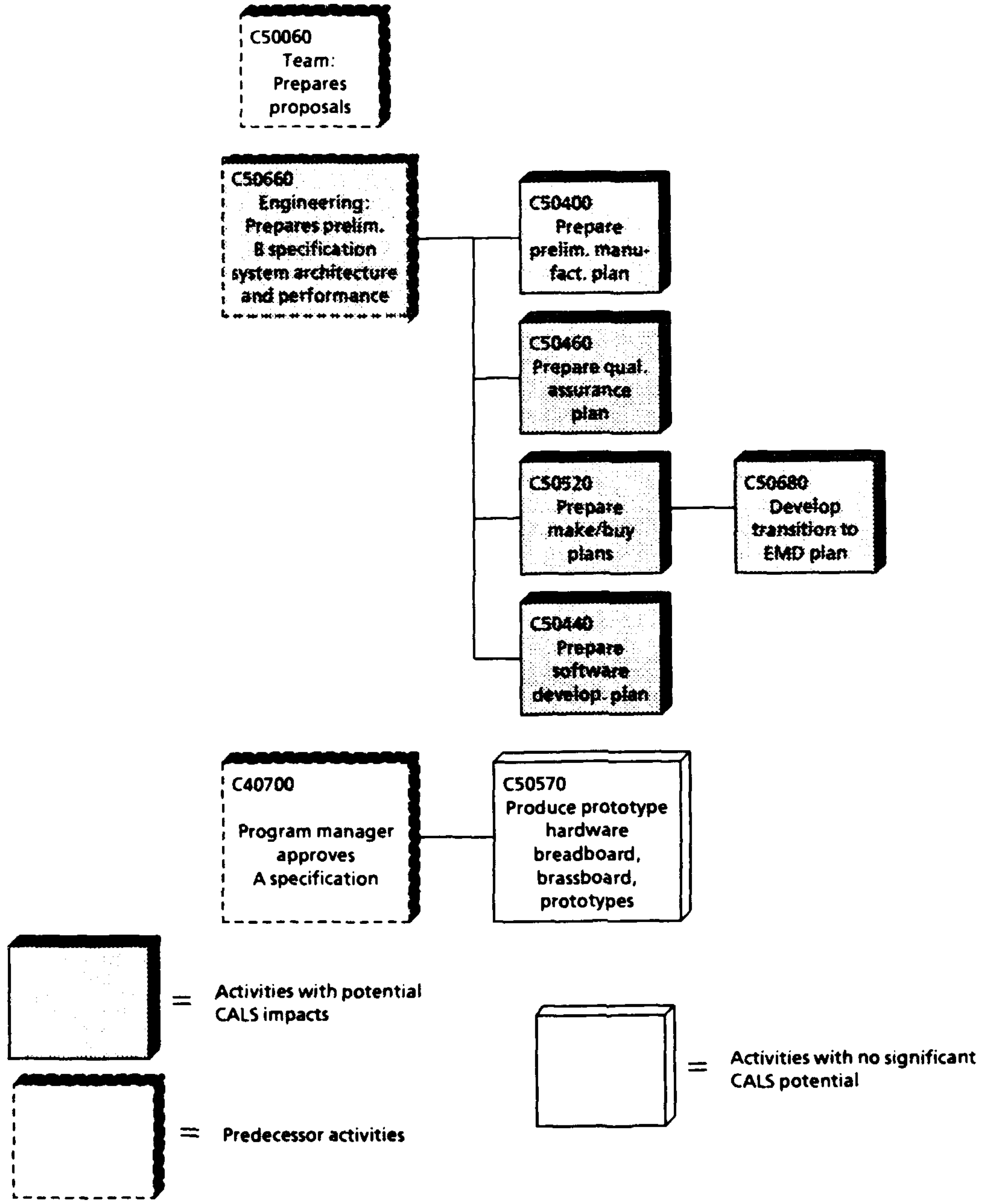
Notes: LRIP = low rate initial production; DT = design test; OT = operational test; TEMP = test and evaluation master plan; CAS = Contract Administration Serv

FIG. A-4. TEST AND EVALUATION – ENGINEERING AND MANUF



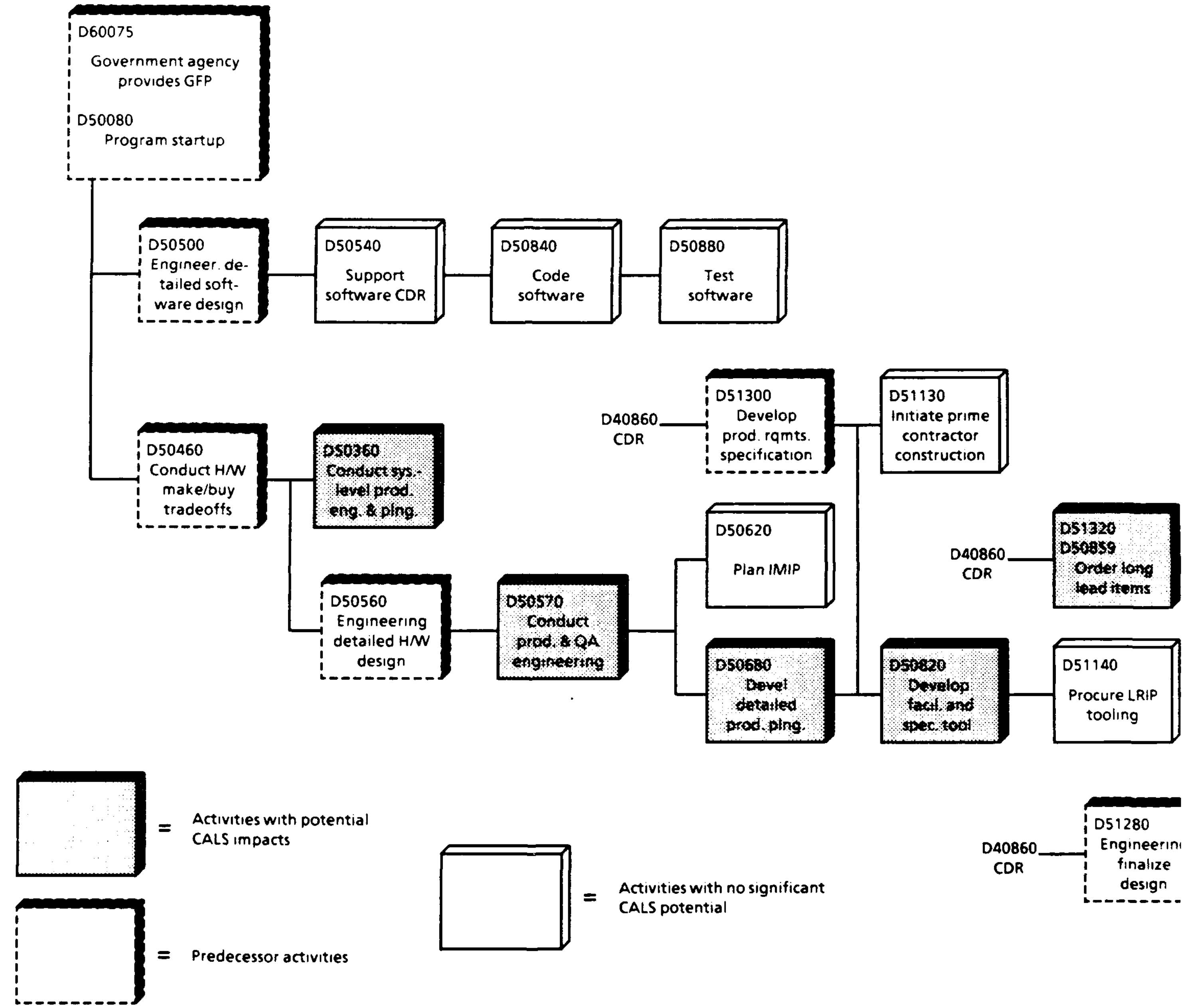
ontract Administration Service

EERING AND MANUFACTURING DEVELOPMENT PHASE



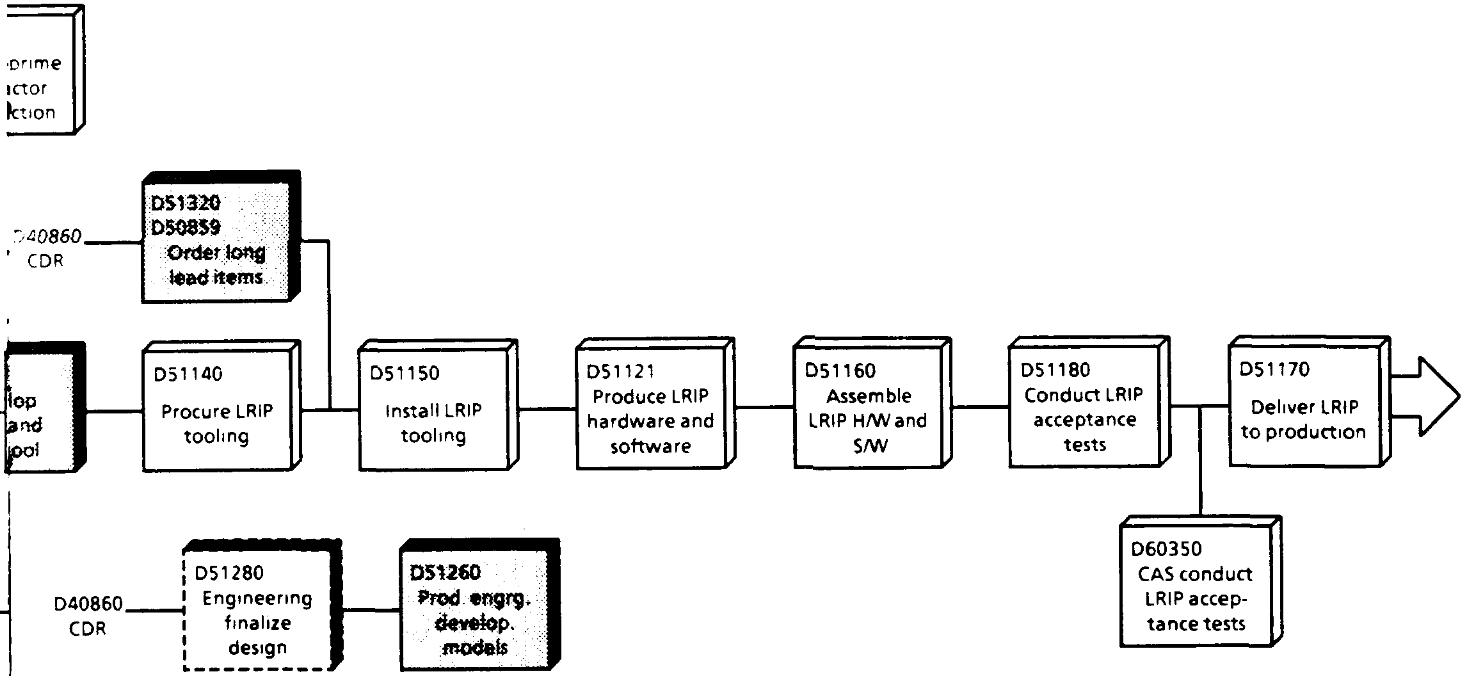
Note: EMD = Engineering and Manufacturing Development

FIG. A-5. MANUFACTURING ACTIVITIES – DEMONSTRATION/ VALIDATION PHASE



Notes: GFP = Government-furnished property; IMIP = Industrial Modernization Incentives Program; CDR = Critical design review; QA = quality assurance.

FIG. A-6. MANUFACTURING ACTIVITIES – ENGINEERING AND MA



w. QA = quality assurance.

ENGINEERING AND MANUFACTURING DEVELOPMENT PHASE

APPENDIX B

COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT COST SAVINGS CATEGORIES

COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT COST SAVINGS CATEGORIES

This appendix summarizes our research into the Computer-aided Acquisition and Logistics Support (CALS) savings experience reported by DoD and industry in the open literature. The savings estimates are grouped in six categories and shown in Tables B-1 through B-6.

TABLE B-1

CATEGORY I: AUTOMATED REVIEW AND APPROVAL PROCESS

Activity	Savings (%)	Source
Reduction in time for process specification compliance for RFP	100	Westinghouse, "Westinghouse Integrated System for the Enterprise: CALS in Action," *Document Management*, November/December 1991
Reduction in planning time	70	*CALS/CE ISG Benefits Working Group Report*, September 1989
Reduction in document change time	30	*CALS/CE ISG Benefits Working Group Report*, September 1989
Reduction in time for engineering data restoration and retrieval	9–12	TASC, AGM-130 Data
Reduction in time for TO review	25	TASC, AGM-130 Data
Reduction in time for retrieval of manufacturing data	12	TASC, AGM-130 Data
Reduction in time for retrieval of historical data	12	TASC, AGM-130 Data
Reduction in time for retrieval of historical engineering data	10	TASC, AGM-130 Data

Notes: RFP = request for proposal; CE = concurrent engineering; ISG = industry steering group; TASC = The Analytic Sciences Corporation; AGM = air-to-ground missile; and TO = technical order.

TABLE B-2

CATEGORY II: ELECTRONIC ACCESS TO CDRL DATA

Activity	Savings (%)	Source
Reduction in data cost	15 – 60	USAF CALS Office, *Forecast and Validation of Benefits*, March 1988
Reduction in time to transport TOs	50	TASC, AGM-130 Data

Notes: CDRL = contract data requirements list; USAF = United States Air Force.

TABLE B-3

CATEGORY III: ACCESS TO CONTRACTOR ANALYSIS TOOLS

Activity	Savings (%)	Source
Reduction in search/retrieval time	40	*CALS/CE ISG Benefits Working Group Report*, September 1989
Reduction in time for engineering data restoration and retrieval	9 – 12	TASC, AGM-130 Data
Reduction in time to verify contractor technical analyses	50	TASC, AGM-130 Data
Reduction in time for retrieval of manufacturing data	12	TASC, AGM-130 Data
Reduction in time for retrieval of historical data	12	TASC, AGM-130 Data
Reduction in time for retrieval of historical engineering data	10	TASC, AGM-130 Data

TABLE B-4

CATEGORY IV: ELECTRONIC DATA INTERCHANGE

Activity	Savings (%)	Source
Image processing		
Increase in efficiency of claims processing	20	Paul Revere Life Insurance Company, *Document Management*, November/December 1991
Cost savings	30	John Hancock Mutual Life Insurance Company, *Document Management*, November/December 1991
Labor cost	33	Stone and Webster, Inc., *Document Management*, November/December 1991
Reduction in data transfer errors	98	CALS/CE ISG Benefits Working Group Report, September 1989

TABLE B-5

CATEGORY V: *DIGITAL DATA DELIVERY* (TDPs, TOs, TMs, TRAINING, LSA DATA)

Activity	Savings (%)	Source
Reduced number of drawings	700	CACI, Inc., Westinghouse, CALS Expo 1991
Reduced publishing expense	70	CACI, Inc., USN PPS, CALS Expo 1991
Reduced publishing manpower	75	CACI, Inc., European Commission, CALS Expo 1991
Reduced documentation cost	10 – 50	USAF CALS Office, *Forecast and Validation of Benefits*, March 1988

Notes: TDPs = technical data packages; TMs = technical manuals; LSA = logistics support analysis; USN = United States Navy; PPS = Printing and Publication Service.

TABLE B-6

CATEGORY VI: CONCURRENT ENGINEERING

Activity	Savings (%)	Source
Reduction in engineering changes	65–95 50	*Business Week*, April 30, 1990 PDES, Inc.
Reduction in time for engineering changes	30–50	*CALS/CE ISG Benefits Working Group Report*, September 1989
Reduction in development time	30–70 82	*CALS/CE ISG Benefits Working Group Report*, September 1989 CACI, ATF, CALS Expo 1991
Reduction in engineering time	60	PDES, Inc.
Reduction in development schedule	50	*CALS/CE ISG Benefits Working Group Report*, September 1989
Reduction in development cost	16–67	TRW, Inc., 4 Programs, CALS Expo 1991
Reduction in N/C programming time	15–40	*CALS/CE ISG Benefits Working Group Report*, September 1989
Reduction in labor hours	30	CACI, F-16, CALS Expo 1991
Reduction in manufacturing cost	25	CACI, ASR-6, CALS Expo 1991
Reduction in production cost	40 15–60	PDES, Inc. USAF CALS Office, *Forecast and Validation of Future Benefits*, March 1988
Reduction in QA processing time	85	*CALS CE ISG Benefits Working Group Report*, September 1989

Notes: N/C = numerical control; QA = quality assurance; PDES = product data exchange using STEP (Standard for the Exchange of Product Model Data); ATF = Advanced Tactical Fighter.

APPENDIX C

COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT COST SAVINGS ESTIMATES

COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT COST SAVINGS ESTIMATES

This appendix presents the savings we estimate are possible for a generic weapon system in engineering, test and evaluation, and manufacturing functions in the demonstration/validation (dem/val) and the engineering and manufacturing development (EMD) phases of the acquisition process. Our estimates are shown in detail in Tables C-1 through C-6. In Table C-7, we summarize total estimated effort and calendar time saved.

We reviewed each activity in Figures A-1 through A-6 of Appendix A that has Computer-aided Acquisition and Logistics Support (CALS) potential (represented by a shaded box) to determine which CALS savings categories from Appendix B were applicable. The mean applied and elapsed times for each activity were then multiplied by the lowest percentage savings estimated for each applicable savings category to estimate potential CALS savings in terms of workweeks and calendar weeks. If activities were affected by more than one category of savings, we limited the savings to some combination of the applicable categories. Times and savings represented by a dash (–) indicate missing or insufficient data points to provide meaningful results. We then combined the estimated savings for each activity to show total savings estimates by function. Adding the savings for the functions established the estimated CALS savings for a generic weapon system in both workweeks and calendar time.

The workweek savings estimate is considered highly conservative since we made no attempt to estimate the values for missing data points and since we used the low end of the range of savings estimates in each savings category. The calendar week savings estimate, however, represents weeks saved from many activities that overlap. Calendar weeks saved for the entire program schedule will, therefore, not be as high as the cumulative total suggests.

The estimated savings were only for activities in three functions in two phases of the acquisition process. While those functions and phases represent areas with the most significant potential for CALS savings, additional savings would be obtained in other functions and other phases as well.

TABLE C-1

ENGINEERING

(Demonstration/validation phase)

Activity[a]	Mean elapsed time (weeks)	Mean applied time (manweeks)	Savings categories	Projected savings	
				Weeks	Manweeks
C50100 Conduct high-level system rqmts analysis	11.0	–	III, VI	4.6	
C50160 Prepare draft system rqmts	21.3		I, VI	8.9	–
C50105 Update SEMP	9.3	–	I, II	2.8	–
C40145 Approve SEMP	57.2	40.5	I	6.8	4.9
C50125 Conduct preliminary synthesis	23.5	–	III, VI	9.9	–
C50220 Conduct LSA	41.7	–	III, VI	17.5	–
C50180 Conduct mission equip. trades	32.5	–	I, III, VI	13.6	–
C40449 Analyze producibility	70.1	170.7	III	8.4	20.5
C40480 Review trade studies	117.3	73.9	I, III	28.1	17.7
C50260 Prepare LSA plan	26.0	–	I, VI	10.4	–
C40500 Approve LSA plan	63.7	52.9	I	7.6	6.3
C40560 Approve contractor plans	74.1	516.4	I	8.9	61.9
C40520 Update ILSP	56.8	42.9	I	6.8	5.1
C50420 Prepare ILSP	52.0	–	I, II	16.6	
C50327 Support prelim. sys. design review	13.8	–	I, III	3.3	
C40680 Conduct prelim. design review	40.3	328.3	I, III	9.7	78.8
C40935 Conduct SDR	32.4	105.3	I, III	7.8	25.2
C40960 Approve plans	123.2	170.8	I	14.8	20.4
C50340 Alternate system concept analysis	26.5	–	VI	7.9	–
C50140 Draft B-2, B-5 specs.	37.9		I, VI	15.9	–
C50110 High-level architecture rqmts. analysis	31.3	–	I, VI	13.2	–
C50120 Identify critical hardware and software items	19.4	–	VI	5.8	–
C40300 Conduct trade studies	124.3	571.0	I, III	29.8	137.0
C40745 Prepare software development plan	–	–	I	–	–
C50520 Perform make/buy assessment	5.1	–	VI	1.5	
C40740 Approve software development plan	89.2	71.5	I	10.7	8.6
C50900 Prepare prelim. system allocation	71.6	–	I, II	22.9	
C50660 Prepare prelim. B spec.	–	–			
C50360 Prepare RSI plan	47.2	–	VI	14.0	–
C50410 Update config. mgmt. plan	11.0	–	I, VI	4.6	
C50501 Update CRLCMP	–	–			
C50685 Support SDR	–	–			
C40700 Approve A spec.	57.2	77.7	I, III	13.7	18.6
C40685 Establish config. control	–	–	–		–
C40710 Approve baseline		–			
C50640 Prepare final reports	–	–		–	–
Total				326.5	405.0

Note: SEMP = systems engineering management plan; LSA = logistics support analysis; ILSP = integrated logistics support plan; SDR = system design review. RSI = rationalization, standardization, and interoperability; CRLCMP = computer resources life-cycle management plan

[a] Activity numbers are from the weapon system acquisition model

TABLE C-2

ENGINEERING

(Engineering and manufacturing development phase)

Activity[a]	Mean elapsed time (weeks)	Mean applied time (manweeks)	Savings categories	Projected savings	
				Weeks	Manweeks
D50085 Update SEMP	15.2		I, II	4.9	
D50220 Complete system architecture	31.8		III, VI	13.4	–
D50160 Conduct hardware reqmts analysis	27.7	–	VI	8.3	
D50240 Conduct software requirements analysis	32.0		VI	9.6	–
D50300 Conduct hardware systems review	–	–	VI		–
D50320 Conduct software systems review	29.0	–	VI	8.7	–
D40790 Conduct in-process design review	26.0	–	I, VI	10.9	–
D50690 Conduct system integration & test planning	28.8	–	VI	8.6	
D51040 Resolve interface compatibility	50.5	–	VI	15.1	
D50460 Conduct hardware & software make/buy analysis	32.8	–	III, VI	13.8	–
D60280 Review hardware & software integration	74.3	73.6	VI	22.3	22.1
D51040 Prepare system test plan	58.9	–	I, II, VI	31.8	–
D50560 Prepare detailed hardware design	72.5	–	VI	21.8	
D40680 Conduct CDR	21.2	153.5	I, III	5.1	36.8
D50120 Conduct tech program planning	24.1	–	VI	7.2	–
D50140 Conduct SRA	35.7	–	VI	10.5	–
D40071 Operate CCB	18.1	5.7	I, III	4.3	1.4
D40260 Approve SEMP	53.5	61.4	I	6.4	7.4
D50440 Conduct software make/buy analysis	49.4	–	VI	14.8	–
D60220 Review B spec.	89.0	127.5	I, III	21.4	30.6
D50500 Perform detailed software design	75.8	–	VI	22.7	–
D40560 Approve B spec.	59.6	82.9	I	7.1	9.9
D40520 Conduct PDR	29.1	119.6	I, III	6.9	28.7
D40540 Conduct supt. equip. PDR	38.0	115.1	I, III	9.1	27.6
D50845 Prepare draft C, D, & E specs.	–	–		–	
D40570 Approve allocated baseline	–	–			–
D50846 Prepare prelim. baseline	–	–	–		–
D50840 Code software	98.9	–	VI	29.6	–
D51280 Finalize design	56.8	–	VI	17.1	–
D40805 Approve baseline	–	–	–	–	–
D40800 Approve final C spec.	143.0	390.0	I, III	34.3	93.6
E40640 Update config. mgmt. plan	18.8	13.4	I, III	4.5	3.2
Total				370.2	261.3

Note: SEMP = systems engineering management plan; SRA = system requirements analysis; CCB = configuration control board; PDR = preliminary design review

[a] Activity numbers are from the weapon system acquisition model.

TABLE C-3

TEST AND EVALUATION

(Demonstration/validation phase)

Activity[a]	Mean elapsed time (weeks)	Mean applied time (manweeks)	Savings categories	Projected savings	
				Weeks	Manweeks
C40380 Form T&E Working Group	48 6	29 3	I, VI	20 4	12 3
C50580 Prepare test support package	54 9	-	I, VI	23 0	
C60220 Review test/insp procedures	68 0	110 5	I, II	21 8	35 4
C60160 Update test plan	65 1	81.3	I, II	20.8	26 0
C50500 Prepare system test plan	75.8	-	I, II	24.3	
C40580 Update TEMP	55.4	36.3	I, III	13.3	8.7
C30240 Review TEMP	56.9	51.1	I, II	18.2	16.3
C70075 Review TEMP	-	-	I, II	-	
C20100 Approve updated TEMP	48 6	13.5	I, II	15 5	4 3
C60166 Schedule test/range facilities	-	-	-		
Total				157.3	103 0

Note: T&E = test and evaluation; TEMP = test and evaluation master plan.

[a] Activity numbers are from the weapon system acquisition model.

TABLE C-4

TEST AND EVALUATION

(Engineering and manufacturing development phase)

Activity[a]	Mean elapsed time (weeks)	Mean applied time (manweeks)	Savings categories	Projected savings	
				Weeks	Manweeks
D50690 Conduct system integration & test	50.5		III, VI	21.2	
D51220 Update test plan	82.9		I, VI	34.8	
D40640 Conduct IV&V of software	154.5	640.0	III	18.5	76.8
D60001 Update test plan	78.24	100.9	I, II	25.0	32.0
D60337 Prepare DTIIB report	–	–	VI	–	
D40860 Review certification for OTIIB	–	–	I, VI	–	
D30110 Review readiness for OT&E	29.6	27.9	VI	8.9	8.4
D70205 Review TEMP	–		I	–	–
D40780 Update TEMP (incl. limited live fire)	66.4	60.0	I, II	21.2	19.2
D30780 Review TEMP	50.4	18.4	I, II	16.1	5.9
D5[illegible] Conduct system integration & test	77.9	–	III, VI	32.7	–
D20400 Approve TEMP	27.5	9.0	I, II	8.8	2.9
D60400 Prepare DTIIB report	67.0	131.5	I, II	21.5	42.1
D60331 Prepare OTIIA report	–	–	I, II		
D60360 Prepare indep. OT&E report	34.2	70.7	I, II	10.9	22.6
D40940 Review test reports	55.4	45.4	I, II	17.7	14.5
D30160 Review test reports	41.0	52.6	I, II	13.1	16.8
Total				250.4	241.2

Note: IV&V = independent verification and validation; OT = design test; OT = operational test.

[a] Activity numbers are from the weapon system acquisition model

TABLE C-5

MANUFACTURING

(Demonstration/validation phase)

Activity[a]	Mean elapsed time (weeks)	Mean applied time (manweeks)	Savings categories	Projected savings	
				Weeks	Manweeks
C50400 Prepare prelim manufacturing plan	34.1	–	VI	10.2	
C50460 Prepare quality assurance plan	32.8	–	VI	9.8	
C50520 Prepare make/buy plans	5.1	-	III, VI	2.2	
C50440 Prepare software development plan	38.7	–	VI	11.6	
C50680 Develop transition to EMD plan	18.4	-	VI	5.5	
Total				39.3	–

[a] Activity numbers are from the weapon system acquisition model.

TABLE C-6

MANUFACTURING

(Engineering and manufacturing development phase)

Activity[a]	Mean elapsed time (weeks)	Mean applied time (manweeks)	Savings categories	Projected savings	
				Weeks	Manweeks
D50360 Conduct system-level production engineering & planning	47.2	–	VI	14.2	-
D50570 Conduct production & QA engineering	66.3	–	VI	19.6	
D50680 Develop detailed production planning	69.5	-	VI	20.8	
D50820 Develop facility and special tooling	86.8	-	VI	26.0	
D50859 Order long lead time LRIP items	–	-	I		
D51260 Produce engineering development models	95.0	-	VI	28.8	
Total				109.4	

Note: QA = quality assurance; LRIP = low rate initial production.

[a] Activity numbers are from the weapon system acquisition model.

TABLE C-7

ESTIMATED GENERIC WEAPON SYSTEM SAVINGS

Function	Acquisition phase	Government effort saved (manweeks)	Time saved (calendar weeks)
Engineering	Dem/val	405	327
Engineering	EMD	261	370
Test & Evaluation	Dem/val	103	157
Test & Evaluation	EMD	241	250
Manufacturing	Dem/val	–	39
Manufacturing	EMD	–	109
Total		1,010	1,252

APPENDIX D

TOP 25 HIGH-APPLIED-TIME ACTIVITIES FROM THE ACQUISITION DATA BASE

TOP 25 HIGH-APPLIED-TIME ACTIVITIES FROM THE ACQUISITION DATA BASE

TABLE D-1

TOP 25 HIGH-APPLIED-TIME ACTIVITIES FROM THE ACQUISITION DATA BASE

Phase	Activity	Function	Mean applied time (manweeks)
Dem/val	Provide laboratory technical developments	Engineering and config. mgmt.	1,426.20
EMD	Provide support for test activities	Test and evaluation	755.10
MA	Identify technology breakthrough (labs)	Engineering and config. mgmt.	337.00
CE/D	Prepare cost and operational effectiveness analysis (COEA)	Program management	297.20
EMD	Conduct design test and evaluation (DT&E) limited live-fire testing	Test and evaluation	276.20
EMD	Independent verification and validation (IV&V) of software	Test and evaluation	265.50
Dem/val	Conduct trade-off studies	Engineering and config. mgmt.	245.30
MA	Conduct long-range R&D planning	Program management	204.00
CE/D	Evaluate concepts	Engineering and config. mgmt.	202.60
MA	Study advanced technology	Engineering and config. mgmt.	196.30
Dem/val	Conduct DT&E	Test and evaluation	182.20
EMD	Conduct operational test and evaluation (OT&E) live-fire testing	Test and evaluation	172.30

Note: Dem/val = demonstration/validation; EMD = engineering and manufacturing development; MA = mission and threat analysis; CE/D = concept exploration and definition.

TABLE D-1

TOP 25 HIGH-APPLIED-TIME ACTIVITIES FROM THE ACQUISITION DATA BASE (Continued)

Phase	Activity	Function	Mean applied time (manweeks)
MA	Conduct technical feasibility study	Engineering and config. mgmt.	171.80
EMD	Participate in and observe user test	Test and evaluation	160.30
Dem/val	Monitor tests	Test and evaluation	144.90
EMD	Monitor tests	Test and evaluation	142.10
Prod	Conduct Government training	Manpower, personnel, and training	126.50
Dem/val	Conduct test planning	Engineering and config. mgmt.	118.40
EMD	Review B specification	Engineering and config. mgmt.	114.70
Dem/val	Perform normal contract administration service (CAS) function	Contracting	113.60
Dem/val	Evaluate and approve contractor plans	Program management	110.90
CE/D	Conduct system requirements review	Engineering and config. mgmt.	108.40
Dem/val	Review program plans and reports	Program management	108.40
EMD	Evaluate sources and negotiate	Contracting	102.30
EMD	Initiate low rate initial production (LRIP) buy	Manufacturing and quality assurance	101.40

Note: Prod = production.

APPENDIX E

ACQUISITION PROBLEM AREAS

ACQUISITION PROBLEM AREAS

This outline of potential acquisition problem areas was drawn from a literature search of weapon system acquisition streamlining studies and from personal assessments by the authors.

DESIGN

Technology Review/Selection

Search for/selection of appropriate technology to meet requirements

Technology transfer from Government Laboratories to contractors

Coordination difficulty in trade-off decisions

Design Quality

Inadequate product design leads to more testing

Integration of electrical, electronic, and mechanical systems[1]

Cost Estimates

Preparation of cost estimates

Engineering Change Proposals/Design Change Notices

Large number of engineering change proposals (ECPs) or design change notices (DCNs)

Parts Selection Decisions

Use of too many nonstandard parts in weapon system designs

Selection of expensive or low-producibility parts in weapon system designs

[1]United States General Accounting Office, GAO/NSIAD 91-5, *Military Airlift: Cost and Complexity of the C-17 Aircraft Research and Development Program*, March 1991, p. 20.

Use of noncommercial specifications and components in weapon system designs

Too many sole-source spare parts[2]

LOGISTICS SUPPORT

Logistics Support Analysis

Logistics Support Analysis (LSA) is less valuable as an aid to analysis and design than as documentation of analysis

LSA reports are not currently delivered to the Government in useful form

Timeliness of Source Data

LSA is in paper format and not available soon enough to adequately support downstream processes [e.g., technical manual (TM) preparation]

Technical manual authoring precedes LSA record (LSAR) availability

Training plan preparation precedes availability of TMs and other source documents

Provisioning Decisions

Inaccurate provisioning decisions

Travel costs for provisioning conferences

Product Descriptions/National Stock Numbers

Too many duplicate National Stock Numbers assigned

Inadequate part/product descriptions

MANUFACTURING

Production

Program stretch-outs reduce production rates, raising unit costs

New acquisition strategy causes a break prior to full-rate production

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[2]United States General Accounting Office, GAO/NSIAD 91-53, *Defense Procurement: Not Providing Technical Data May Limit Defense Logistics Agency Competition*, January 1991, pp. 4 – 5.

Government-Furnished Equipment

Mistiming of Government-furnished equipment (GFE) delivery leads to scheduling delays

TECHNICAL INFORMATION

Technical Data Packages

Incomplete technical data [provisioning technical documentation (PTD), supplementary PTD (SPTD), technical data packages (TDPs)]

Technical data errors delay procurement (administrative lead times are too long)

Cost of providing TDPs to potential suppliers[3]

Government inability to process computer-aided design/computer-aided manufacturing (CAD/CAM) data (vector graphics)

Customized/proprietary manufacturing processes limit universal use of TDPs

Inability to guarantee complete TDP from initial review

Legibility of TDPs on microform[4]

Documentation

Difficulty in documenting advanced designs

Design sophistication/instability adversely affects TM accuracy/usefulness

Feedback

Lack of operational feedback to logistics engineers doing LSA

Inadequate feedback to TM authors

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[3]United States General Accounting Office, GAO/IMTEC 91-54, *Defense ADP: A Coordinated Strategy is Needed to Implement the CALS Initiative*, September 1991, pp. 8 – 9.

[4]United States General Accounting Office, GAO/NSIAD 92-23, *Defense Procurement: Improvement is Needed in Technical Data Management*, February 1992, p. 4.

Data Updates

Update of TDPs

Costly TM updates[5]
Training is often not consistent with the latest fielded configuration

Review and Approval Process

Parts control/ECP approvals are slow and often overtaken by events

Data/report review-and-approval times are too long

Technical Data Management

Inadequate distribution of technical data to DoD repositories

High cost of indexing TDPs

Ordering too much or too little technical data

Inadequate consideration of life-cycle cost/benefit in data requirements decisions

Data Access

Test plans with wrong design limits lead to more testing

Inefficient Contract Administration Service (CAS) access to necessary contract performance information

Inefficient access to information for evaluating contractor plans and reports

Lack of visibility of pending and recent design changes at the inventory control point level[6]

Many reports are not used due to limited resources, poor format, or poor accessibility

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[5]United States General Accounting Office, GAO/IMTEC 91-54, *Defense ADP: A Coordinated Strategy is Needed to Implement the CALS Initiative*, September 1991, pp. 8 – 9.

[6]United States General Accounting Office, GAO/NSIAD 91-53, *Defense Procurement: Not Providing Technical Data May Limit Defense Logistics Agency Competition*, January 1991, pp. 4 – 5.

Legacy Data

Large amounts of active technical data are in paper, microform, or other non-Computer-aided Acquisition and Logistics Support format.[7]

CONTRACTING

Contracting procedures are often limiting factors for schedule, cost, and performance

TRAINING

Inadequate instructor training for complex systems

Inadequate training equipment for complex systems

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[7] United States General Accounting Office, GAO/NSIAD 92-23, *Defense Procurement: Improvement is Needed in Technical Data Management*, February 1992, pp. 18–23.

APPENDIX F

FUNCTIONAL PROCESSES WITH POTENTIAL HIGH PAYOFFS FROM CALS APPLICATIONS

FUNCTIONAL PROCESSES WITH POTENTIAL HIGH PAYOFFS FROM CALS APPLICATIONS

This appendix groups potential acquisition problems from Appendix E into functional processes that have potentially high payoffs from the application of Computer-aided Acquisition and Logistics Support (CALS) processes.

DESIGN

Functional Process Area: Concurrent Engineering Support

- Inadequate product design leads to more testing
- Integration of electrical, electronic, and mechanical systems[1]
- High engineering change proposal/design change notice volumes

Functional Process Area: Contractor Access to DoD Supply System

- Use of too many non-standard parts in weapon system designs
- Selection of expensive or low-producibility parts in weapon system designs
- Use of noncommercial specifications/components in weapon system designs

LOGISTICS SUPPORT

Functional Process Area: Provisioning

- Inaccurate provisioning decisions

TECHNICAL INFORMATION

Functional Process Area: Technical Data Packages

- Incomplete technical data [e.g., provisioning technical documentation (PTD), supplementary PTD (SPTD), technical data packages (TDPs)]
- Technical data errors delay procurement (administrative lead time is too long)

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[1]United States General Accounting Office, GAO/NSIAD 91-5, *Military Airlift: Cost and Complexity of the C-17 Aircraft Research and Development Program*, March 1991, p. 20.

- Large amounts of active technical data are in paper, microform, or other non-CALS format[2]
- Inadequate distribution of technical data to DoD repositories
- Slow TDP updates

Functional Process Area: Technical Manuals

- Costly technical manual updates[3]

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[2]United States General Accounting Office, GAO/NSIAD 92-23, *Defense Procurement: Improvement is Needed in Technical Data Management*, February 1992, pp. 18 – 23.

[3]United States General Accounting Office, GAO/IMTEC 91-54, *Defense ADP: A Coordinated Strategy is Needed to Implement the CALS Initiative*, September 1991, pp. 8 – 9.

APPENDIX G

BENEFITS ANALYSIS

BENEFITS ANALYSIS

TABLE G-1

BENEFITS ANALYSIS

Weight[a]	Benefit	Concurrent engineering support	Engineering change proposal processing	Technical data packages	Parts control	Provisioning	Technical manuals
100	Fewer design changes	X					
95	Lower life-cycle cost	X	X	X	X	X	X
90	Performance to spec.	X	X				
85	Higher reliability/ availability	X	X	X	X		X
85	Lower production costs	X	X	X	X		
75	Faster development	X	X	X	X		
70	Faster testing	X					
60	Better provisioning	X	X	X	X	X	
50	Faster organic supply support	X	X	X	X	X	
40	Lower inventory costs		X	X		X	
35	More effective training	X	X	X		X	X
30	Fewer technical manual changes	X	X	X		X	
	Totals[b]	775	645	555	450	310	215

[a] Weights were assigned by the study team based on collective judgment regarding the overall life-cycle impact of each benefit.

[b] Totals were assigned by adding the weight for each benefit marked with an "X" in each column.

APPENDIX H

COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT STANDARDS

COMPUTER-AIDED ACQUISITION AND LOGISTICS SUPPORT STANDARDS

Responsibility for developing and maintaining Computer-aided Acquisition and Logistics Support (CALS) standards falls within the CALS Evaluation and Integration Office (CEIO). In discussing activities and tasks in this appendix, we refer to the CEIO staff working through an appropriate coordinating activity [e.g., the CALS Management Advisory Council (CMAC)]. We prioritize each recommended action as high, medium, or low priority for the CEIO.

MILITARY GRAPHICS REPRESENTATION SPECIFICATIONS: MIL-D-28000, MIL-R-28002, AND MIL-D-28003[1]

Status

An amendment to Military Specification MIL-D-28000 is scheduled to be published in November 1992. The latest version of MIL-R-28002 is in production for publication in December 1992, and an amendment to MIL-D-28003 was published in September 1992.

Issues

The CALS Phase I standards for graphics cover most but not all of the kinds of graphic information needed to describe a weapon system. In particular, MIL-D-28000 which is based on the American National Standards Institute (ANSI) Interim Graphics Exchange Standard (IGES) for describing mechanical computer-aided design (CAD) product data needs to be supplemented with other standards for electronic design data. These standards are referenced in Military Standard MIL-STD-1840.[2] The critical issue with MIL-D-28000 is when to replace it with the requirement for the Standard for the Exchange of Product Model Data (STEP). It is too early to determine accurately when STEP will be widely available in products, and no alternative standard is being developed. No benefits will accrue from STEP

[1]MIL-D-28000A, *Digital Representation for Communication of Product Data: IGES Application Subsets and IGES Application Protocols*, 10 February 1992; MIL-R-28002A, *Raster Graphics Representation in Binary Format, Requirements for*, 30 November 1990; MIL-D-28003A, *Digital Representation for Communication of Illustration Data: CGM Application Profile*, 15 November 1991

[2]MIL-STD-1840A, *Automated Interchange of Technical Information*, 20 December 1988.

until sufficient vendor support is available. Therefore, DoD must continue to depend on MIL-D-28000 and the supplemental standards referenced in MIL-STD-1840.

MIL-R-28002 is based on international imaging standards recommended by the International Consultative Committee on Telegraphy and Telephony (CCITT), the same organization that promulgated the standard used by fax machines. The CCITT recommendations were also adopted by the Office Document Architecture (ODA) standard that MIL-R-28002 also references.

Earlier versions of MIL-R-28002 were not widely adopted because of nonstandard byte-encoding schemes and limitations in its ability to support large engineering drawings. Development of the version about to be published fixes those problems. The new version was also coordinated with the imaging industry and with input from Government users and standards developers. The main issues are whether MIL-R-28002 will, in fact, become widely supported by vendors and if so, how soon. Related to these issues is the question of compatibility with other large commercial initiatives that have adopted the CCITT recommendations but not necessarily MIL-R-28002.

The Tag Image File Format (TIFF) standard for encoding images has already been widely adopted by industry and is supported in many off-the-shelf products. The effect of the acceptance of TIFF and other options [e.g., the upcoming addition of color raster capability in the Computer Graphics Metafile (CGM) standard] on the adoption of MIL-R-28002 should be determined.

MIL-D-28003 is based on the International Standards Organization (ISO) CGM standard and is suitable for describing illustrative graphics. No competing international standard exists although there are other competing standards. The key issue with MIL-D-28003 is whether it is kept consistent with ISO CGM and whether it is compatible with off-the-shelf products that support CGM.

The three military standards for graphics would be more widely supported if an acceptable conformance testing program was available. The marketplace in many cases automatically helps ensure that products conform to widely adopted standards. CCITT, CGM, and TIFF are examples of market pressures creating agreement among product vendors. This is less true of IGES. The market on its own is not going to come up with conformance testing for CALS-specific applications of these standards because the commercial benefits from that testing are simply not enough.

DoD has three primary alternatives in response to the lack of conformance testing for military graphics standards. The first is to rely on accepted commercial graphics standards in lieu of military ones, thus taking advantage of conformance testing conducted for the larger commercial graphics market but forgoing the opportunity to tailor the standards to unique military uses. The second alternative is to establish and fund a DoD conformance testing program for its own military graphics standards. The third alternative is to arrange for a third party [e.g., the National Institute for Standards and Technology (NIST)] to conduct conformance testing of military standards. Costs of the second two alternatives could be reduced if DoD encouraged use of current conformance testing capabilities for aspects of the military standards that are common with the commercial standards, thus limiting the need for separate conformance testing to unique aspects of the military standards.

Recommended actions for graphic representation standards are shown in Table H-1.

THE MILITARY TEXT STANDARD: MIL-M-28001[3]

Status

As a DoD application of the ISO Standard Generalized Markup Language (SGML) standard, MIL-M-28001 was designed specifically to describe a digital representation of technical manual data for neutral interchange and delivery.

MIL-M-28001B is scheduled to be released in January 1993. Two earlier versions of MIL-M-28001 have been in use in industry since February 1988. The use of SGML tags to encode data in MIL-M-28001 is widely supported by vendors in off-the-shelf products. The section of MIL-M-28001 dealing with the description of how to format this information for presentation is partially supported by industry. Industry and Government have discussed and reached some agreement on the content of a future MIL-M-28001C, but no active development is under way.

[3]MIL-M-28001A, *Markup Requirements and Generic Style Specification for Electronic Printed Output and Exchange of Text*, 1 October 1991.

TABLE H-1

RECOMMENDED ACTIONS FOR MIL-D-28000, MIL-R-28002, AND MIL-D-28003

Milestone	Task	Priority
1	Review MIL-R-28002 compatibility with other industry activities (e.g., ATA, ODA) using CCITT recommendations	High
2	Develop a forecast for acceptance of MIL-R-28002 by industry in relation to acceptance of other imaging standards	High
3	Create a cost model for near-term adoption of MIL-R-28002 compared with TIFF and other CCITT applications for PM guidance	High
4	Collect data on the actual use of all three graphic standards by programs and contractors, and on support by vendors. Determine how much encouragement is required from DoD.	High
5	Task DISA to maintain MIL-D-28003 to keep current with the ISO CGM standard and industry adoption	Medium
6	Identify organization to establish CALS standards conformance testing (NIST, DISA)	Medium
7	Task DISA to perform cost and risk analysis on migrating MIL-D-28000 to STEP	Low

Note: ATA = Air Transport Association; PM = program manager; DISA = Defense Information Systems Agency.

The CALS Industry Steering Group's Electronic Publishing Committee (EPC) developed MIL-M-28001 and its two major revisions. It also developed a series of Technical Capability Action Plans (TCAPs) that were presented to the Defense CALS Executive as industry recommendations for further standards development in SGML and other electronic publishing standards. By joint agreement with the Defense CALS Executive, the EPC's role was to shift from standards development to standards review, and the Government was to assume responsibility for future standards development using the TCAPs for reference. The Defense CALS Executive needs to accelerate action on the TCAPs and on actual standards development. An example of action required is the restructuring of MIL-M-28001 to remove the tag listing from the static specification environment and place it in a data base environment where it can be updated easily and quickly.

Issues

Four critical issues affect the implementation of MIL-M-28001:

- It was designed specifically to deal with paper output and page-oriented digital data, which makes it suitable for many existing programs. However, MIL-M-28001 is not sufficient for data-base-oriented digital delivery and presentation of technical information to users. Immediate, clear guidance to PMs is necessary on use of MIL-M-28001 and interactive electronic technical manuals for weapon system programs.

- Users have evolving requirements that force them to modify implementations of MIL-M-28001. A process to establish and maintain a data/dictionary tag library and to manage evolving requirements has been developed but is not adequately funded.

- The output specification (the Formatting Output Specification Instance or FOSI application) needs additional development. Here, there are three areas in need of attention: FOSI development for functional specifications, output specification enhancements and testing to ensure complete support for paper deliverables, and output specification extensions or the development of a Document Style and Semantics Specification Language (DSSSL) application for electronic delivery. This last area coincides with the need for development of interactive electronic technical manual (IETM) "view package" specifications. The consensus among technical experts is that sufficient commonality exists between page-based and IETM formatting and presentation that a single formatting and presentation specification may be able to address both types. Since one specification would cost less than two, DoD should resolve the issue soon to avoid unnecessary costs should a single specification be feasible.

- No conformance testing is performed. Conformance testing guidance has been developed by ANSI for the standard SGML, but industry association activity to apply it has not received sufficient funding. DoD should establish its own conformance testing of MIL-M-28001 (the DoD interpretation of the ANSI SGML standard) to encourage vendor support but only after a data/dictionary tag library and application management responsibility are in place. Once vendor support for MIL-M-28001 is established, DoD conformance testing could be reduced or eliminated.

Recommended actions for the text standard are shown in Table H-2.

TABLE H-2

RECOMMENDED ACTIONS FOR MIL-M-28001

Milestone	Task	Priority
1	Review Military Handbook (MIL-HDBK)-59A[a] to ensure there is sufficient and accurate guidance concerning how to specify MIL-M-28001	High
2	Review TCAPs and take action on those approved	High
3	Fund tag/data dictionary management. Develop policy on data dictionary maintenance and on using SGML applications other than MIL-M-28001.	Medium
4	Fund a consolidated effort to stabilize and extend the capability to exchange formatting information for both paper and electronic deliverables	Medium

[a]MIL-HDBK-59A, *Department of Defense Computer-Aided Acquisition and Logistic Support (CALS) Program Implementation Guide*, for personnel responsible for acquisition and use of weapon system technical data.

THE MILITARY STANDARD FOR AUTOMATED INTERCHANGE OF TECHNICAL INFORMATION: MIL-STD-1840

Status

A new revision of MIL-STD-1840 (1840B), scheduled for release in November 1992, includes direction on delivery of digital information on diskettes and optical disks and over networks.

Issues

The challenge for MIL-STD-1840 is to keep up with changes to the CALS specifications and standards it incorporates, to provide guidance on the delivery of information not covered by other CALS standards, and to provide direction on the use of alternative media for digital delivery. Since this standard requires constant maintenance, full-time personnel should be assigned to it. It has not been well accepted in the past because it has not reflected the latest changes. MIL-STD-1840 must also reflect the reality of day-to-day commerce. The standards it requires must be widely supported and in use. In particular, the way that information is electronically exchanged over networks should be carefully reviewed.

Recommended actions for MIL-STD-1840 are shown in Table H-3.

TABLE H-3

RECOMMENDED ACTIONS FOR MIL-STD-1840

Milestone	Task	Priority
1	Review MIL-STD-1840B to ensure alternative delivery mechanisms reflect industry support. In particular, support of Government Open Systems Interconnection Profile (GOSIP)	Medium

THE STANDARD FOR ACCESS TO CONTRACTOR TECHNICAL INFORMATION: MIL-STD-CITIS (MIL-STD-975)

Status

A second draft of MIL-STD-CITIS will be published for review in November 1992. It is scheduled for publication in June 1993.[4]

Issues

The first draft of the CITIS specification was controversial because it described a radically new way of doing business with DoD. The new draft is likely to be significantly more acceptable to industry. However, in spite of substantial industry involvement, the main issue remains obtaining industry concurrence. The focus needs to be on what information the DoD wants to acquire and how it wants to acquire it and not on how contractors should manage it (except in the sense of quality guarantees) or what their software should do.

Recommended actions for MIL-STD-CITIS are shown in Table H-4.

[4]MIL-STD-CITIS (Draft), Contractor Integrated Technical Information Service.

TABLE H-4

RECOMMENDED ACTIONS FOR MIL-STD-CITIS

Milestone	Task	Priority
1	Develop a plan for and conduct the widest industry review possible of MIL-STD-CITIS to ensure industry support	Medium

THE INTERACTIVE ELECTRONIC TECHNICAL MANUAL (IETM) SPECIFICATIONS: MIL-D-IETMDB, MIL-Q-IETMQA, AND MIL-M-GCSFUI[5]

Status

The tri-Service committee responsible for the IETM specifications has created a set of specifications that can be used in the procurement of technical information in digital data base form for presentation on electronic media. These specifications are analogous to existing Technical Manual Specifications and Standards (TMSS) for paper deliverables except that they take advantage of advances in digital technology.

The IETM specifications are a logical step beyond the existing CALS Phase I standards but retain the use of SGML as the interchange standard, thereby avoiding cost of converting data created according to MIL-M-28001.

These tri-Service IETM specifications are being finalized for release after coordination and comment resolution from the Services and industry and are scheduled to be published in December 1992.

Issues

Because the Joint Computer-aided Acquisition and Logistics Support (JCALS) program places emphasis on arriving at an early solution to the technical manual problem, the IETM specifications must be compatible with the JCALS approach. Those specifications already represent a tri-Service consensus that is compatible with JCALS. Importantly, both approaches use the same underlying standards (SGML,

[5]MIL-D-IETMDB (Draft), *Data Base, Revisable: Interactive Electronic Technical Manuals, For the Support of*, 1 April 1991. MIL-R-IETMQA (Draft), *Quality Assurance Program: Interactive Electronic Technical Manuals and Associated Technical Information; Requirements for*, 1 April 1991. MIL-R-GSCFUI (Draft), Manuals, Interactive Electronics Technical: General Content, Style, Format, and User-Interaction Requirements, 1 April 1991.

HyTime).[6] Both approaches also use new technology and, as such, entail some amount of risk. Coordinating and consolidating these efforts will significantly reduce the risk and eliminate redundancy.

Another area in which additional investigation is needed is the overlap between the data elements in MIL-D-IETMDB, MIL-M-28001, other functional specifications that have defined data elements (e.g., MIL-M-38784C, and MIL-STD-1388-2B).[7,8]

Recommended actions for IETM specifications are shown in Table H-5.

TABLE H-5

RECOMMENDED ACTIONS FOR THE IETM STANDARDS

Milestone	Task	Priority
1	Assign personnel to JCALS/IETM integration team	High
2	Develop JCALS/IETM Integration Plan	High
3	Develop near-term IETM policy, include in MIL-HDBK-59A	High
4	Obtain vendor input and support for IETM/JCALS approach	High
5	Assign tri-Service and DISA R&D resources to maintain IETM/JCALS specs.	Medium
6	Investigate and make recommendation on consolidation of data elements in technical specifications	Medium

MIL-HDBK-VP

Status

MIL-HDBK-VP (Draft), *Preparation of View Packages in Support of Interactive Electronic Technical Manuals*, is a draft specification.

Issues

Technical work remains to be completed in the area of specifying and exchanging view packages (VPs), the electronic equivalent of paper technical

[6]HyTime is an international standard that defines a model and language for representing documents that link and synchronize static and time-based information.

[7]MIL-M-38784C, *Manuals, Technical: General Style and Format Requirements*, 29 July 1991.

[8]MIL-STD-1388-2B, *DoD Requirements for a Logistic Support Analysis Record*, 28 March 1991.

manuals. The technical issues here largely overlap those facing the output specification (FOSI) and ISO DSSSL developers.

Recommended actions for MIL-HDBK-VP are shown in Table H-6.

TABLE H-6

RECOMMENDED ACTIONS FOR MIL-HDBK-VP

Milestone	Task	Priority
1	Assign a working group made up of DISA, IETM, JCALS, and industry experts to "fast track" this problem and the completion of the output specification	High

INTERNATIONAL INDUSTRY STANDARDS

Status

The ATA and Aerospace Industry Association have been developing the ATA-100 specification[9] to deal with electronic creation and delivery of aircraft maintenance information for commercial airlines and their suppliers. The newer versions of ATA-100 include guidance on the use of many of the same standards that CALS has adopted (SGML, CGM, CCITT). Applications of electronic delivery of information based on ATA-100 already exist.

The Association Europénnee des Constructeurs de Matériel Aérospatial (AECMA) has produced the AECMA 1000D and 2000M specifications[10] whose purpose is to aid in sharing technical and materiel information among European partners involved in joint development of aircraft. They also base these standards on many of the same international standards CALS has adopted (e.g., SGML and CCITT).

[9]ATA-100, *Specification for Manufacturer's Technical Data*, 15 January 1981.

[10]AECMA 1000D, *International Specification for Technical Publications Utilizing a Common Source Data Base*, December 1989. AECMA 2000M, *International Specification for Materiel Management: Integrated Data Processing for Military Equipment.*

Issues

European government and commercial organizations have expressed strong interest in coordinating MIL-D-IETMDB, MIL-STD-1388-2B, and MIL-M-28001 with the AECMA 1000D and 2000M standards and are also interested in MIL-STD-CITIS. Coordination with those Government and commercial activities will help further the goals of the CALS effort in the United States in three important ways:

- It will reduce costs. DoD will pay a higher price for information technology products if industry has to support three different schemes for acquiring and managing technical data. Most U.S. companies that supply technology to DoD also provide technology to these other markets in the United States and internationally.
- The DoD can learn from the experiences of these other initiatives, some of which are progressing at a faster rate than CALS; thus, it will reduce the risk and accelerate the achievement of DoD's CALS goals.
- CALS will benefit from the consolidation and rationalization of data elements that have to be managed.

Recommended actions for international industry standards are shown in Table H-7.

TABLE H-7

RECOMMENDED ACTIONS FOR INTERNATIONAL INDUSTRY STANDARDS

Milestone	Task	Priority
1	Designate a formal liaison with each activity and provide that liaison with the responsibility and the resources for managing appropriate consolidations such that they further DoD's goals	High

INTERNATIONAL STANDARDS ORGANIZATION STANDARDS

Standard Generalized Markup Language

Worldwide, SGML has been adopted by many commercial and Government organizations including the commercial aviation industry in the United States and

Europe, the automotive industry, and the telecommunications industry. Within DoD Components, there are at least 20 applications of SGML in addition to MIL-M-28001.

Status

Since 1986, SGML has been an ISO standard. It is currently undergoing the standard ISO 5-year review process. National bodies have contributed comments concerning user requirements; no significant changes are planned. The interests of CALS have been included unofficially in U.S. comments by industry members.

Issues

The NATO Industrial Advisory Group (NIAG) study[11] recommended that CALS adopt the entire SGML feature set, as opposed to current DoD policy expressed in MIL-M-28001. This recommendation merits serious consideration because international industry and Government partners as well as other domestic organizations will be taking advantage of additional features.

The only significant issue with SGML itself revolves around understanding what it does and does not provide. Because of the large number of different SGML applications within DoD, program managers need educational assistance and guidance. Because policy decisions have to be made on coordinating multiple DoD SGML applications with NATO, European Community (EC), and commercial applications, DoD decision makers need to have ready access to expertise.

Recommended actions for SGML are shown in Table H-8.

HyTime

Status

HyTime, which recently has become a full ISO standard, is based on SGML and therefore consistent with CALS Phase I data. It provides for neutral interchange of the multimedia data bases required for IETMs. MIL-D-IETMDB and JCALS solutions incorporate HyTime because of its sophisticated object-linking capability. HyTime has the ability to describe synchronized events so that an IETM with audio,

[11] *NATO Industrial Advisory Group CALS Study*, NIAG Study Group 35, October 1991.

TABLE H-8

RECOMMENDED ACTIONS FOR THE SGML STANDARD

Milestone	Task	Priority
1	Assign point-of-contact responsibility for SGML expertise to CALS, DISA, JCALS, and AFMC organizations	High
2	Review MIL-HDBK-59A to ensure it provides sufficient and accurate guidance on SGML	High
3	Develop plan for DoD-wide guidance on use of SGML, including recommendation on the use of the full SGML feature set[a]	High
4	Develop tutorial on the use of SGML for DoD application	High

Note: AFMC = Air Force Materiel Command.

[a]See the "issues" section in the earlier discussion of MIL-M-28001 in this appendix.

text, and video elements can be properly synchronized for presentation to a technician.

Issue

Off-the-shelf products that completely support HyTime are not widely available, although some SGML products support it.

Recommended actions for HyTime are shown in Table H-9.

TABLE H-9

RECOMMENDED ACTIONS FOR THE HYTIME STANDARD

Milestone	Task	Priority
1	Monitor use of HyTime to determine when/if it should be more widely used	Low

Document Style and Semantics Specification Language

Status

The DSSSL fills a crucial gap in international standards, especially from a CALS point of view. While other standards deal with formatting and presentation interchange (ODA, for example), no others provide a general mechanism for supporting the wide range of requirements necessary for diverse types of technical information.

Issue

The output specification in MIL-M-28001 provides a means for exchanging formatting information for paper output and can be extended to provide for electronic display; however, it should be replaced by DSSSL at an appropriate time in an orderly manner. It is especially important to pursue this area since IETMs also need to be able to interchange electronic view packages. DSSSL is scheduled to become a full ISO standard in 1993. DSSSL progress should be monitored closely because it has the potential to provide a significant benefit.

Recommended actions for the DSSSL standard are shown in Table H-10.

TABLE H-10

RECOMMENDED ACTION FOR THE DSSSL STANDARD

Milestone	Task	Priority
1	DISA should participate in the DSSSL standards work to determine when and if it should be adopted by CALS	Low

Standard Page Description Language

Status

Standard Page Description Language (SPDL) is a new ISO standard. It combines the features of many existing page description languages and is very close to the Post Script language. Its value is dependent on its adoption by industry. If it is supported by the large suppliers of printing technology, it will be a great benefit to CALS and will not be costly or risky.

Issue

If SPDL is not supported and DoD nevertheless requires it on contracts, it would provide no value and would increase cost. It is not yet commercially available. The major suppliers of page description languages (PDLs) and printers were involved in the development of SPDL and will support it if sufficient demand develops. CALS could provide some encouragement, but industry support will not be widely available in the next year.

Recommended actions for the SPDL standard are shown in Table H-11.

TABLE H-11

RECOMMENDED ACTIONS FOR THE SPDL STANDARD

Milestone	Task	Priority
1	Assign the Industry Steering Group to determine interest in SPDL; DISA to analyze its benefits and monitor	Low

Standard for the Exchange of Product Model Data (Product Data Exchange Using STEP)

Status

When complete, STEP will have a major effect on the existing CALS standards. It encompasses the functionality of at least some parts of all the current CALS standards. STEP will be published in parts as each is completed over the course of the next few years. A well-structured process should introduce STEP into CALS by ensuring that adequate conformance testing and an extensive vendor base are available prior to full-scale transition from existing standards to STEP. That process needs to be developed.

Issue

The critical issue for CALS is how to convert from the current set of CALS standards and the data being created with them to a STEP environment. While it will be years before this transition has to take place, it is important to plan for it now.

Recommended actions for the STEP standard are shown in Table H-12.

TABLE H-12

RECOMMENDED ACTIONS FOR THE STEP STANDARD

Milestone	Task	Priority
1	Set up formal liaison between maintainer of each of the CALS Phase I standards and the appropriate STEP subcommittee	Medium
2	Assign DISA the task of evaluating the transition issues from the current CALS standards to STEP	Low
3	Task DISA to develop a plan and schedule for transition	Low

APPENDIX I

PROPOSED REVISIONS TO MILITARY STANDARDS, DIRECTIVES, AND SPECIFICATIONS

PROPOSED REVISIONS TO MILITARY STANDARDS, DIRECTIVES, AND SPECIFICATIONS

This appendix summarizes the revisions to regulatory documents recommended to support Computer-aided Acquisition and Logistics Support (CALS) implementation in the weapon system acquisition process. These documents were identified on the basis of governing documents referenced in the acquisition data base. Additional regulatory document revisions are cited with specific proposed CALS applications in Chapter 4. Potential revisions would need to be coordinated with cognizant functional offices, shown in brackets for each document.

ENGINEERING

Military Standard MIL-STD-499B, *Engineering Management* [Air Force Materiel Command, Code EN]

Currently, MIL-STD-499B is being revised and could be directly influenced during the review cycle. The current draft version contains a significant number of design and development reviews. The need for and cost of these reviews could be reduced considerably by implementing CALS technologies, but only passing reference is made to CALS in the document.

We suggest the following modifications be made to MIL-STD-499B:

- *Section 2*: Insert appropriate references to CALS standards.
- *Sections 4 and 6*: The need for specific design review and content should be determined on the basis of the contractor's ability to provide the necessary integrated technical data to the Government in digital format to ensure appropriate Government oversight.
- *Paragraph 4.1(a)*: Add as last sentence: "These documents shall be prepared, updated, and maintained in digital formats consistent with applicable CALS standards."
- *Paragraph 4.6.6(e)*: Delete current wording, replace with "Be consistent with CALS standards."
- *Paragraph 6.4.4*: Contractor decision data base should be maintained in a digital form consistent with CALS standards.

DoD Standard DoD-STD-2167A, *Defense System Software Development* [Space and Naval Warfare Systems Command/Code 003-114]

Software is a major cost and schedule driver in acquisition programs. This standard defines the software development process and associated design reviews but does not capitalize on CALS application. The software development process and environment is currently being reviewed by the Director of Defense Research and Engineering (DDR&E). We recommend that the Defense CALS Executive explore CALS application to the software development process with DDR&E in the areas of software reuse, documentation, update, and distribution.

MIL-STD-1521B, *Technical Reviews and Audits for Systems, Equipments, and Computer Software* [Air Force Materiel Command, Code ALET]

This standard defines the requirements for design and system reviews and associated documentation. It makes no reference to CALS. We suggest the following modifications:

- *Section 4*: Insert the preference for CALS and on-line access.
- *Section 6*: Insert the option to provide deliverables via on-line access and/or digital form.
- Insert MIL-STD-CITIS (Contractor Integrated Technical Information Service) as a reference in applicable Statements of Work.

MIL-STD-490A, *Specification Practices* [Air Force Materiel Command, Code SDXP]

This standard sets the practices for the preparation, interpretation, change, and revision of program specifications prepared by or for DoD. The identification of CALS and the CALS requirements in this standard is essential to the implementation of CALS in the engineering process. At present, this standard does not reference CALS. To reflect the intent of DoD Instruction (DoDI) 5000.2, *Defense Acquisition Management Policies and Procedures*, within MIL-STD-490, we suggest the following modifications:

- *Section 2*: Insert a reference to MIL-STD-CITIS.
- *Section 6*: Insert the preference for access to contractor information through CITIS and the option of on-line access to data deliverables where feasible.

TEST AND EVALUATION

Test planning is primarily governed by DoD Directive (DoDD) 5000.3-M-4, *Joint Test and Evaluation Procedures Manual.* The directive does not reference CALS or CALS technologies although CALS could be applied to test data integration, use, and reuse. Modifications should be made to paragraphs C.1(a), C.4(a), C.7(e), and E.1(c). Coordination would be required with DDR&E and Under Secretary of Defense (Acquisition) [USD(A)].

MANUFACTURING AND QUALITY ASSURANCE

Manufacturing

The following standards are related to manufacturing processes and practices but provide no reference to CALS. They should be revised to provide for on-line access to data deliverables or for delivery in digital format.

- MIL-STD-1521B, *Technical Reviews and Audits for Systems, Equipments, and Computer Software*, [Air Force Materiel Command, Code ALET]
- MIL-STD-1567A, *Work Measurement* [Air Force Materiel Command, Code ALET]
- MIL-STD-1528A, *Manufacturing Management Program*, [Air Force Materiel Command, Code EN]

In MIL-STD-1567A, the metrics of contractor performance are shown at the lowest level, but the standard does not address how the developed data are to be stored, accessed, or analyzed. We suggest that MIL-STD-1567A be further modified as follows:

- *Section 2*: Include reference to MIL-STD-CITIS.
- *Section 4*: Insert preference for CITIS.

MIL-STD-1528A controls many aspects of manufacturing, including required metrics and contractor deliverables. These are some of the core issues for CALS, and this standard will have to be revised to develop the contractor data and data access that will enable the redesign of the acquisition process. We propose the following further modification to MIL-STD-1528A:

- *Paragraph 2.0*: Add reference to CALS standards to "Reference Documents."
- *Paragraph 4.1*: Add as a last sentence: "These data and documentation shall be prepared, updated, and maintained in digital formats consistent with applicable CALS standards."
- *Paragraph 4.1.3*: Reduce annual audit requirement.
- *Section 5*: Insert appropriate references to provide for the digital format and access to required contractor analyses to be consistent with CALS standards.
- *Paragraph 5.3.3*: Revise to include any appropriate metrics required to determine effectiveness of CALS methods.
- *Paragraph 5.3.4*: Revise to include any reference to CALS standards, digital format, and delivery requirements that are to flow down to the subcontract level.
- *Paragraph 5.3.5*: Revise to include reference to digital format and delivery, and consistency with CALS standards and the appropriate data item descriptions (DIDs).
- *Paragraph 5.5(i)*: Revise to include reference to digital format and delivery, and consistency with CALS standards and the appropriate DIDs.

The following manufacturing-related standards and specifications are instructive in nature (i.e., "how to") and have no apparent CALS requirement:

- MIL-STD-1189B, *Standard DoD Barcode Symbology*, 10 August 1989
- MIL-STD-1367A, *Packaging, Handling, Storage and Transportability Program Requirement for Systems and Equipments*, 2 October 1989
- MIL-STD-130G, *Identification Marking of U.S. Military Property*, 11 October 1988
- MIL-STD-2000A, *Standard Requirements for Soldered Electrical and Electronic Assemblies*, 14 February 1991
- Military Specification MIL-I-8500D, *Interchangeability and Replaceability of Component Parts for Aerospace Vehicles*, 25 March 1980

Quality Assurance

The following three primary standards and specifications are related to quality assurance:

- MIL-Q-9858A, *Quality Program Requirements*, Headquarters, U.S. Air Force, 5 March 1985 [Office of the Deputy Assistant Secretary of the Air Force (Management Policy and Program Integration), Manufacturing and Quality Division, Code SAF/ARXM]
- MIL-I-45208A, *Inspection System Requirements*, 24 July 1981 [U.S. Army Armament, Munitions, and Chemical Command, Code SMCAR-BAC-S]
- MIL-STD-45662A, *Calibration Systems Requirements*, 1 August 1988 [U.S. Army Missile Command, Code AMSMI-RD-SE-TD-ST]
- MIL-STD-1535A, *Supplier Quality Assurance Program Requirements*, 1February 1974 [Air Force Materiel Command, Code ENSP]

MIL-Q-9858A is the overriding contractor standard. It does not address the digital format, accessibility, or currency of contractor quality data. The standard only addresses the type of quality data required and that it be provided to the Government "upon request." Tailoring this standard should be a high-priority CALS target. We suggest the following modifications:

- *General*: Direct the availability of all quality data and data analyses in CALS-compliant digital format.
- *Paragraphs 3.4, 3.5, and 3.6*: Revise to provide for CALS-compliant digital format and digital exchange of data.

We suggest the following modifications to Military Specifications MIL-I-45208A and MIL-STD-45662A:

- Insert appropriate references to CALS standards.
- Encourage the digital exchange of data generated by these system requirements.

MIL-STD-1535A governs the supplier/subcontractor quality assurance program requirements. We suggest the following modifications be made to MIL-STD-1535A:

- Insert appropriate references to CALS standards.
- Require digital exchange of nonconformance data and processing data on registered components.

APPENDIX J

PROPOSED REVISIONS TO MILITARY HANDBOOK MIL-HDBK-59A

PROPOSED REVISIONS TO MILITARY HANDBOOK MIL-HDBK-59A

In this appendix, we propose some specific revisions to Military Handbook MIL-HDBK-59A, *DoD Computer-Aided Acquisition and Logistic Support Program Implementation Guide.*

MAIN BODY

- *Page 2, Paragraph 4.3 and 4.4*: The reference to the Deputy Secretary of Defense memorandum should be changed to reference DoD Instruction (DoDI) 5000.2, *Defense Acquisition Management Policies and Procedures*, 23 February 1991, Part 6, Section N.
- *Page 8, Paragraph 5.1*: Update with information about the current Contractor Integrated Technical Information Service (CITIS) standard.
- *Page 19, Paragraph 5.2.1.4*: This paragraph places the entire burden of developing a Computer-aided Acquisition and Logistics Support (CALS) cost/benefit analysis, including Government benefits, on the contractor. It is unlikely that the contractor will know what the Government's expected benefits will be. Those benefits will depend upon the extent of CALS implementation, standards development, technology infrastructure, etc. DoD should develop a CALS business case to document Government costs and benefits. A CALS business case will assist the program manager in assessing the costs and benefits of contractor CALS implementation plans. Another approach to help enforce CALS usage would be to assume that it is beneficial and require a cost/benefit justification for not selecting CALS methods.
- *Page 23, Paragraph 5.2.3.1*: The discussion on archiving should refer to the National Archives and Records Administration guidelines.
- *Page 33, Paragraph 6.2*: The key words should be defined and added to a glossary.

APPENDIX A

Some of the material in Appendix A duplicates portions of the material covered under the General and Specific Guidance sections in the main body of the handbook. One example is the discussion of CITIS that appears on pages 8 and 54. The handbook could be streamlined by consolidating coverage and eliminating repetition.

Also, some of the paragraphs exhorting the CALS purpose, philosophy, strategy, etc., could probably be condensed into shorter policy statements. The background material in Appendix A should appear in the beginning of the handbook, before the General and Specific Guidance sections.

- *Pages 37–42*: An updated list of specifications should be made into a separate appendix.
- *Pages 43–50*: The glossary of terms should be removed from Appendix A and placed at the end of the handbook.
- *Page 59, Paragraph 40.3.2*: This paragraph suggests that the only near-term benefit of CALS is the conversion of paper deliverables to digital deliverables. Some long-term benefits, such as process improvement, are available in the near term through on-line access to digital data, simultaneous routing of information, electronic review and approval, etc.
- *Page 67*: The CALS points of contact should be updated.
- *Page 68*: The memorandum has been superseded by policy at DoDI 5000.2, Part 6, Section N.

APPENDIX B

- *Page 74, Paragraphs 40.1 and 40.2*: This material duplicates the coverage found on pages 2 and 8, respectively, of the main body.
- *Page 74, Paragraph 40.2*: The wording in this paragraph puts the burden of assessing the Government's capabilities and plans for using digital technical data on the acquisition manager. This assessment helps determine the extent of CALS implementation in the program. The acquisition manager would be aided in this assessment by knowing the short-, mid-, and long-term DoD CALS implementation strategies. We recommend that such strategies be developed and publicized in the handbook or otherwise made available to program managers.
- *Page 79, Section 50.2*: The discussion of technical manuals should also include coverage of the Joint CALS (JCALS) program. Interactive electronic technical manual standards should also be discussed.
- *Page 89, Paragraph 50.3.2*: The section on engineering drawings should also cover electronic indexing data. Some policy regarding legacy data should be included. One of our recommendations is to require digital delivery of both existing and new data when technical data managers order data for a weapon system. This will help to convert legacy data to a CALS-compliant format.

APPENDIX C

- *Page 147, Paragraph 50.2.5.2.4*: The suggested wording for tailoring data item description language says that delivery of data in digital format is "encouraged." To enforce CALS, the wording should be strengthened to read "required."

APPENDIX D

This section is technically complex and probably of little help to a program manager who is not familiar with telecommunications standards. This section should be simplified and incorporate more examples showing how to structure a solicitation to meet various telecommunications scenarios.

APPENDIX E

Coverage is needed on protection of contractor intellectual property rights in a CALS environment. The Defense Federal Acquisition Regulation Supplement Part 27 establishes data rights policy, but guidance should be given on how the identification and marking requirements are accomplished in an interactive digital CALS environment.

APPENDIX K

EXAMPLES OF GOVERNMENT AND INDUSTRY SAVINGS FROM USING CALS/CONCURRENT ENGINEERING

EXAMPLES OF GOVERNMENT AND INDUSTRY SAVINGS FROM USING CALS/CONCURRENT ENGINEERING

This appendix summarizes the savings experienced by Government and industry organizations that have implemented CALS/concurrent engineering concepts in their operations.

AGM-130 AIR-TO-GROUND MISSILE PROGRAM

The following savings are attributed to CALS implementation on the AGM-130 program:

- Savings of 45 – 60 minutes per day for each of 50 people for engineering data storage and retrieval;
- A reduction of 30 – 50 percent in the personnel needed to verify contractor technical analyses;
- Savings of 45 – 60 minutes a day for 8 people in the retrieval of historical test data;
- Savings of 40 hours a week tracking, coordinating, and compiling comments; and
- A reduction of 25 percent for 3 people for technical order review.

WESTINGHOUSE ELECTRIC CORPORATION

By using concurrent engineering techniques, Westinghouse estimated saving 10 – 20 percent cycle time in hardware design development and transition to production. Actual results from implementation ranged from 35 – 75 percent.[1]

DIGITAL EQUIPMENT CORPORATION

The Digital Equipment Corporation's (DEC's) RA90 disk drive project used its information environment and technology to establish and link a project team that was scattered across seven locations in the United States and West Germany. DEC

[1]Westinghouse Electric Corporation, Manufacturing Systems and Technology Center, *A Concurrent Engineering Model of the Design and Manufacturing Process for Electronic Assemblies*, Scott E. Dahne, February 1992.

used tools such as electronic mail, electronic conferencing, data and information exchange, business analysis and graphics tools, and shared computing resources to link users. Results of the project include the following:

- 50 percent improvement in product reliability over previous products at the same point in the product life cycle;
- 50 percent reduction in cost per megabyte of storage capacity;
- 45 percent reduction in program staff requirements;
- 75 percent reduction in installation problems at customer sites;
- 50 percent reduction in ramp-up to volume production; and a
- Reduction in the development cycle from 6 years to 3 years.[2]

NORTHROP CORPORATION B-2 PROGRAM

The B-2 bomber is the first aircraft ever built using a three-dimensional (3D) integrated data base, which ties in engineering, manufacturing, logistics, subcontractors, and the Air Force into one data base that holds complete B-2 product definition. The integrated data base increases productivity, allowing some combination of further refinement or faster completion of weapon system designs. The B-2 data base has reduced significant misalignment of parts by about 6 to 1.

Using 3D mockups instead of physical mockups, Northrop achieved a 97 percent fit yield on hydraulic tubing, as compared with the F/A 18 aircraft program, which used a physical mockup and had yields under 50 percent. The 3D system did not speed up drafting time, but it helped identify problems early, allowing for more robust designs. Because of the cultural change required, the chief engineer for the B-2 program recommends gradually implementing Contractor Integrated Technical Information Service (CITIS). Northrop offered the capability of getting traditional hard-copy data as well, and the chief engineer feels that was vital for easing the transition to an electronic environment.[3]

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[2]Digital Equipment Corporation, *Managing Complexity: Cooperation an ' Integration in the RA90 Project*, Case Study Series FY90-1, September 1989.

[3]Andrew Schamisso, "Creating Teamwork in Engineering," *Machine Design*, March 26, 1992, pp. 99 – 106.

TRW, INC., SPACE AND DEFENSE SECTOR

TRW analyzed four projects in an attempt to determine a benefit-to-cost ratio (B/C) in terms of dollars for concurrent engineering. Each project used a different number and/or mix of concurrent engineering tools. All the projects showed a positive B/C ratio, with a low of 2.8:1 and a high of 17.3:1. Three of the four projects reported reductions in schedule, thereby saving labor costs. The other project, the Command Center Processing and Display System – Replacement for the Air Force's Cheyenne Mountain Upgrade Program – reported a 50 percent reduction in changes per month compared with projects using the traditional approach.

CALS would support some of the techniques mentioned in this study, such as multidisciplinary teams, a common user interface, customer on-line access, and a lessons-learned data base. Further research is needed to isolate concurrent engineering features in cost reporting. More detailed budgeting models with concurrent engineering features and activity-based costing to track resources more accurately would help to isolate benefits.[4]

CALS BENEFITS WORKING GROUP

A number of examples of CALS benefits were cited from industry and DoD:[5]

- Computer-aided design (CAD) update of drawing packages reduced processing time from 2 workweeks to half a day.
- Level-of-repair analysis process was reduced from 4 workmonths to 4 to 5 days through customer on-line review/approval. Model output delivery was reduced from 3 days to 20 minutes.
- An automated training plan for Navy equipment brought about an 85 percent reduction in labor time for preparation as compared with the previous method, which required manual documentation and calculations.
- A CALS integrated logistics support (ILS) system for a major aerospace weapon system reduced ILS planning and management, training, technical publication writing, logistics support analysis, and provisioning each by a third to a half. Labor reductions ranged from 30 – 60 percent, for an approximate saving of $19 million.

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[4]Diana Nickelson and David Belson, "Measuring the Economic Impact of Concurrent Engineering," *CALS Journal*, Summer 1992.

[5]*Computer-aided Acquisition and Logistics Support (CALS) Benefits Working Group Report*, September 8, 1989.

- At McDonnell Douglas, CALS is reducing costs 25 – 30 percent and cycle time 20 – 25 percent in comparison to manual design and documentation systems.

BEST MANUFACTURING PRACTICES

The best manufacturing practices (BMP) data base has cataloged a number of best practices related to acquisition cycle time. The following are examples where CALS could be applied:[6]

- At International Telephone and Telegraph (ITT) Avionics Division, logistics engineers utilize an on-line logistics support analysis (LSA) data base. The LSA data base enhances testability through effective design review and timely feedback to design engineers. LSA data are derived from the same data base used by design and test engineering. The on-line LSA data base can be accessed by manufacturing, design, and logistics groups.

- McDonnell Aircraft Company implemented a concurrent engineering organization with extensive use of CAD for the development of the night attack nose cone for the AV-8B aircraft. Significant savings were achieved. The production article was delivered 5 months ahead of schedule because of a 2-month reduction attributable to 3D layouts and a 3-month reduction attributable to tool definition. The program saw no tool rework, no part rework, and virtual elimination of assembly fit-up problems. Design changes were reduced from 6.0 to 0.2 per drawing.

- Litton Applied Technology Division has implemented a computerized assembly planning and documentation system that allows fast turnaround of changes in processes or parts and prevents more than a 1-day production of items produced to earlier out-of-date specifications. The system automatically updates all drawings and instructions that relate to a changed part or assembly, and it has an electronic approval process. The system has saved 25 percent of the labor for assembly document generation and 50 percent of the labor for document maintenance.

INDUSTRY BEST PRACTICES

Booz, Allen & Hamilton's survey of industry best practices revealed that an integrated product/process development (IPPD) could reduce design cycle time by up to 50 percent. Elements of IPPD include multifunctional design teams, colocation of program team, small/empowered program management office, specification completeness/stability, integrated design tools, and an electronic documentation

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[6]Logistics Management Institute and Computer Sciences Corporation, *Best Manufacturing Practices Data Base, Team 2 – Best Practices Plans and Progress*, Appendix C, 27 June 1990.

system. Benefits found from using integrated design and documentation tools include the following:[7]

- Overall 10 percent drop in design time because of seamless design tools.
- A 90 percent reduction in document transfer times.
- Seamless data transfer, which avoids injecting new errors into data.
- Electronic documentation systems, which can cut engineers' applied documentation time by 30 percent.
- Savings of 50 percent in elapsed/applied documentation time because of an electronic documentation system. Another program reduced document applied time by 30 percent.
- Benefits of multifunctional design teams include greater producibility and less rework. Total time saved is estimated at 5 percent overall elapsed/applied time. CALS can support multifunctional design teams through electronic colocation and electronic review and approval capability.

[7]Booz, Allen & Hamilton, Inc., *DSB Acquisition Streamlining Task Force Team 2 – Industry Best Practices*, 14 December 1990.

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13. ABSTRACT ***(Maximum 200 words)***
Since 1988, DoD has required use of Computer-aided Acquisition and Logistics Support (CALS) technology for all new weapon system acquisitions and for existing weapon system programs, where cost-effective. We identify the DoD acquisition processes with the highest potential payoff from CALS applications and estimate related DoD workload reductions. We also identify implementation actions and necessary policy or standards changes required to implement selected CALS applications. We conservatively estimate that a DoD acquisition program for a typical weapon system will save more than 1,000 workweeks (19.4 workyears) of DoD effort and over 1,250 calendar weeks among the individual, and often concurrent, acquisition tasks. We anticipate the highest CALS payoffs in the engineering and configuration management, test and evaluation, and manufacturing functions during the demonstration and validation and the engineering and manufacturing development acquisition phases. We conservatively estimate that nine proposed CALS applications in four functional areas will save over $165 million annually DoD-wide. The technology and standards needed to implement CALS throughout DoD is available, but DoD needs to modernize its infrastructure and obtain functional manager support for streamlined business processes before it can achieve most of those savings.

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